Duplicate

REPORT OF THE COMMITTEE OF INQUIRY ON Foot-and-Mouth Disease 1968

PART ONE

Presented to Parliament by the Minister of Agriculture, Fisheries and Food by Command of Her Majesty

April 1969

LONDON

HER MAJESTY'S STATIONERY OFFICE

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COMMITTEE OF INQUIRY ON FOOT-AND-MOUTH DISEASE

MINUTE OF APPOINTMENT

I hereby appoint

The Duke of Northumberland, K.G., T.D., J.P.

A. Cripps, Esq., D.S.O., T.D., Q.C.

Professor D. G. Evans, D.Sc., Ph.D., F.C.Path., F.R.S.

C. H. Plumb, Esq.

Sir Edward Thompson, M.B.E., T.D.

Professor D. Walker, M.A.

Professor Sir William L. Weipers, B.Sc., F.R.C.V.S., D.V.S.M., F.R.S.E.

to be a Committee to review the policy and arrangements for dealing with foot-and-mouth disease in Great Britain and to make recommendations.

I further appoint the Duke of Northumberland to be Chairman of the Committee and Mr. J. N. Jotcham to be Secretary, and Mrs. M. D. White to be Assistant Secretary of the Committee.

(Sgd.) FREDERICK PEART
Minister of Agriculture, Fisheries and Food.

28*th February*, 1968.

In addition to the above I hereby appoint

E. L. Thomas, Esq., LL.B., J.P.

to be an additional member of the Committee.

(Sgd.) CLEDWYN HUGHES
Minister of Agriculture, Fisheries and Food.

22*nd April*, 1968.

PART 1 OF THE REPORT OF THE COMMITTEE OF INQUIRY ON FOOT-AND-MOUTH DISEASE

To the Rt. Hon. CLEDWYN HUGHES, M.P.
Minister of Agriculture, Fisheries and Food.

SIR,

We were appointed on 28th February, 1968:—

" to review the policy and arrangements for dealing with foot-and-mouth disease in Great Britain and to make recommendations ".

We now have the honour to submit Part I of our Report.

We have given priority to consideration of the ways by which the risk of the introduction of foot-and-mouth disease virus into Great Britain, and the risk of future epidemics, might be reduced. Our major task has therefore been to accumulate and evaluate the available scientific evidence and to weigh up the advantages and disadvantages of various possible policies. We have held 29 meetings in this country and have visited Denmark, France, the Federal Republic of Germany, the Netherlands, Argentina, Brazil and Uruguay. The objects of these visits were to hold general discussions on foot-and-mouth disease and to familiarise ourselves with control programmes and the disease situation in these countries. We also visited the Centro Pan-Americano de Febré Aftosa in Rio de Janeiro and we met officials of the United States Department of Agriculture in Washington and at the Plum Island Animal Disease Laboratory, Long Island, New York. We received evidence from the Food and Agriculture Organisation of the United Nations and from the Office International des Epizooties. Many countries helped us by supplying information which we had requested. A large number of organisations and individuals in this country submitted written evidence, and with some of these we have discussed their memoranda. A list of those persons and bodies from whom we have received evidence is in Appendix I.

We wish to thank all our witnesses in this country for the efforts they made on our behalf. Also we are greatly indebted to all those who played a part in the arrangements for our visits to Europe and to North and South America. We deeply appreciate the kindness and courtesy with which we were received, and the frank and full assistance given to us in the conduct of our inquiries.

We interpret our terms of reference as demanding the fullest possible information we can provide about foot-and-mouth disease and its control and that it is not for us to attempt to express judgments on the social, political and commercial implications of the policy we recommend.

Part I of our Report gives general information about foot-and-mouth disease and deals with measures designed to reduce the incidence of primary outbreaks and the risks of such outbreaks giving rise to epidemics. There remain matters of detailed arrangements if outbreaks occur, including compensation and valuation, which will be the subject of our recommendations in Part II; on these matters we shall be taking further evidence.

A summary of our recommendations is given in Chapter VIII. Anthony Cripps, Q.C. does not wholly agree with all these recommendations. The extent of his disagreement is covered by a Dissenting Note containing his recommendations.

Note: The estimated cost of the Committee's inquiries to 31st March 1969, including the cost of producing Part 1 of the Report, is £13,653 19s. 0d. of which £1453 19s. 0d. represents the estimated cost of printing and publication.

PART 1 OF THE REPORT OF THE COMMITTEE OF INQUIRY ON FOOT-AND-MOUTH DISEASE

CONTENTS

TABLES

FIGURES

MAPS

PHOTOGRAPHS

APPENDICES

CHAPTER I

INTRODUCTION

1. Foot-and-mouth disease is one of the most infectious of all animal diseases. It was first recorded in Great Britain in 1839 and measures for its control were the subject of legislation before the end of the nineteenth century. On three occasions in the past fifty years Committees have been appointed to investigate the cause of outbreaks in Great Britain and to make recommendations on policy, prevention and control arrangements.*

2. The present Committee was appointed following the 1967/1968 epidemic. Our Report, which we are presenting in two parts, will describe the developments that have taken place since the Report of the Departmental Committee on Foot-and-Mouth Disease 1952–54 (the Gowers Committee Report). Part I deals with measures designed to reduce the incidence of primary outbreaks of foot-and-mouth disease in Great Britain and the risks of such outbreaks giving rise to epidemics. Part II will deal with such matters as organisation, administration, procedures relating to slaughter and disposal of carcases, sanitary controls, compensation and valuation. In these matters the Ministry of Agriculture, Fisheries and Food (referred to subsequently as the Ministry of Agriculture) have the benefit of long experience, and their record over the years has been one of considerable achievement. We therefore think it would be wrong to delay the recommendations in Part I of our Report until the completion of Part II which will include a review of the detailed control arrangements and ancillary matters. Inevitably there will be some overlap between the two parts.

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* (i) Report of the Departmental Committee on Foot-and-Mouth Disease, 1922. (Chairman, Captain the Right Hon. E. G. Pretyman, M.P.) (Cmd. 1784.)

(ii) Report of the Departmental Committee appointed to consider the outbreak of foot-and-mouth disease which occurred in 1923–1924. (Chairman, Captain the Right Hon. E. G. Pretyman.) (Cmd. 2350.)

(iii) Report of the Departmental Committee on Foot-and-Mouth Disease 1952–1954. (Chairman, Sir Ernest Gowers, G.B.E., K.C.B.) (Cmd. 9214.)

CHAPTER II

FOOT-AND-MOUTH DISEASE AND ITS EPIDEMIOLOGY

(*a*) The Disease

3. We confine ourselves at this point to the main features of foot-and-mouth disease. A detailed description is given in Appendix II. The disease is caused by a virus visible only by using the electron microscope. The virus remains viable under many conditions but it can be destroyed by heat, direct sunlight, acids and alkalis and some disinfectants. There are seven known major virus types—

A : C : O : Asia 1 : SAT. 1 : SAT. 2 : SAT. 3.

Sub-types occur within these seven major types and more than fifty sub-types have so far been identified. The immunological difference between the major types is specific and well defined; thus animals which have recovered from infection with one type are for some time immune to that type but they are susceptible to the others. The immunological difference between some sub-types is slight but between others it may be considerable. Foot-and-mouth disease virus may display varying characteristics in relation to infectivity, stability under laboratory tests, severity of the disease, propensity to attack one species of animal rather than another, power of survival outside the animal and ability to stimulate immunity.

4. Cloven-hoofed animals are the natural hosts of foot-and-mouth disease virus. Domestic cattle and pigs are those which most frequently succumb to attack by the virus, sheep rather less frequently and goats still less. Wild cloven-hoofed animals are all apparently susceptible in varying degrees. Hedgehogs have been involved in outbreaks in this country. Man has on very rare occasions been infected; one definite case occurred in Northumberland in 1966. It is unlikely, however, that infection in man plays a part in the spread of the disease. Experimental work has indicated that rats may carry the virus in their gut for long periods following ingestion of infected material and are therefore a potential risk but records do not permit us to conclude whether they can be naturally infected. Laboratory animals such as guinea-pigs may be infected experimentally but they do not develop the disease naturally.

5. Animals are infected with foot-and-mouth disease virus by direct contact with an infected animal. They may also contract the disease indirectly through contact with material contaminated by the virus, for example contaminated feedingstuffs or air.

6. The incubation period after infection varies. It is usually three to eight days but it can be shorter or it may extend to fourteen days or perhaps more. In typical cases the disease is readily diagnosed. In cattle, for example, in the early stages food is refused and lameness follows; salivation, which may be profuse or slight, occurs and is associated with smacking of the tongue and grinding of the teeth. Vesicles (blisters), which are easily ruptured, appear on any part of the mucous membrane of the mouth and occasionally on the udder. The bulb of the heels and the interdigital spaces are commonly affected. In

young calves, however, the characteristic clinical appearances and the post-mortem changes may be absent. In other species there is some variation in the clinical signs of the disease and in the distribution of lesions (see Appendix II).

7. Foot-and-mouth disease varies in its virulence depending on the species of animal affected and on the strain of virus responsible for the outbreak; it can range from a mild form, which may be difficult to diagnose clinically, to one of high severity. In general the death rate from foot-and-mouth disease in adult animals is not high. In Europe, for example, before the introduction of the slaughter policy, the death rate in cattle was estimated to be between one and three per cent. The majority of animals in an infected herd make a gradual recovery after three or four weeks, but in a dairy herd an economic production level is seldom reached during the current lactation, and permanent damage may result, leading to the necessity for heavy culling. The death rate may be higher in young calves and pigs, and in ewes and lambs during the lambing season.

8. Foot-and-mouth disease virus may be present in all parts of the body; it is highly concentrated in the fluid of the vesicles and it is secreted or excreted in the milk, saliva, urine and faeces. All secretions and excretions may contain some virus before the animal has shown signs of the disease and virus may be present in these after the peak of development of lesions. Animals may become carriers and harbour the virus for several months after recovery (see paragraphs 42–45).

(*b*) Epidemiology

9. The incidence of foot-and-mouth disease varies in different parts of the world (see Chapter III). In some parts it is completely absent, as in Australia, Canada, Ireland, New Zealand and the U.S.A.; in others it is present in endemic form as in some parts of South America; in other parts it occurs only sporadically as in Great Britain (see Chapter IV).

Endemic, epidemic and sporadic disease

10. In countries where the disease is *endemic*, foot-and-mouth disease virus, causing clinical or sub-clinical infection, is continuously present in some animals. Thus the virus does not need to be introduced into these countries to cause an outbreak. Considerable resistance to infection may be shown by certain indigenous species and the presence of the disease may not always be obvious. This is especially true of sheep and also of wild cloven-hoofed animals. Periodically there is an upsurge of the disease, particularly when the susceptible population of young animals reaches a high proportion. This could result in an *epidemic* with widely-spread outbreaks. At this stage the disease may become more virulent, resulting in a higher death rate. With the spread of the epidemic many of the animals in the country become exposed to the disease and this is followed by the development of immunity; a period of quiescence follows although pockets of disease still remain. The disease may flare up again with an increase in the number of young, susceptible animals or when an outbreak due to a different type of foot-and-mouth disease virus occurs.

11. *Sporadic* disease occurs in countries which have periods free of the disease; it appears when foot-and-mouth disease virus is introduced from abroad. Countries which have a completely susceptible animal population, as well as those which practise vaccination, may suffer from sporadic outbreaks. Successful control eliminates the disease and a period then follows when the country is completely free from the virus, but where control measures are not successful, a sporadic outbreak may develop into one of epidemic proportions.

Factors involved in the introduction and spread of the disease

12. Foot-and-mouth disease presents serious problems because of the highly infectious nature of the virus and its ability to survive outside the animal host for long periods. Many factors may contribute to the introduction and spread of the disease and these are discussed in the following paragraphs.

(i) *Imported animals*

13. The disease risks associated with the importation of live animals have long been recognised. Most countries, including Great Britain, control imports of livestock from abroad.

(ii) *Imported fresh, chilled and frozen meat and offal*

14. Shortly after a healthy animal is slaughtered an acidity develops in the muscles, giving rise to rigor mortis. This reaction can destroy foot-and-mouth disease virus present in the muscle. Acid changes do not take place in any other part of the carcase and thus, if the virus were present, it could survive in bone marrow, lymph nodes, liver and kidney. If freezing or very rapid chilling is carried out immediately after slaughter, the acidity and associated rigor mortis do not develop, and in these circumstances the virus could survive for some months in muscle as well as in the bone marrow, the offal and those other parts already mentioned. Survival of the virus can be prolonged if infected carcases or offal are held in a chilling temperature or a frozen state. Its presence has been demonstrated after about six months in bone marrow stored at 1 °C and in frozen offal for at least four to five months. There is no doubt that parts of carcases of animals slaughtered when the virus is present, whether the animals are showing clinical signs or not, can be a dangerous source of infection. However, a study by the Argentine-United States Joint Commission on Foot-and-Mouth Disease has shown that the risk of the virus being present in meat is very much less in vaccinated animals even when they have recently been exposed to infection because the multiplication of virus in such animals is inhibited.

15. Meat, offal and bones from infected carcases may be used in preparing swill for feeding to pigs. Thus swill can constitute a serious risk if it is fed to susceptible animals before it is sterilised. Outbreaks of disease may more often be attributed to the removal of uncooked swill by dogs, cats, birds and vermin to fields, yards and buildings where there are susceptible animals. Kitchen waste stored in uncovered bins, or when carried and spilled from uncovered or unsecured transport, presents another hazard. It is also possible that an outbreak may occur as a result of a farm worker handling swill and then coming into contact with susceptible animals.

16. Bones given to farm dogs may be brought into contact with susceptible animals on any part of the farm. Some bones are disposed of by butchers as

waste which may be taken to a refuse tip. Once there, they constitute a disease risk, particularly on tips in rural areas. Even a controlled tip is not safe since birds can get at the bones before they are covered and can carry small bones and fragments to fields nearby.

17. Although it is known that offal and bones constitute a major risk, we can find only two recorded outbreaks—one in this country and one abroad—attributed to meat where foot-and-mouth disease virus was recovered from commercial carcases associated with an outbreak. Both cases involved pork; in one it was fresh and in the other it was frozen. We do not, however, regard our inability to acquire further evidence of this nature as significant since it is only comparatively recently that virological techniques have been developed that are suitable for the extensive testing that would be necessary to examine a large consignment of imported meat.

(iii) *Bones, hooves and horns*

18. It is known that foot-and-mouth disease virus survives for long periods in bone from infected animals and there is a possible risk of imported bones, hooves and horns introducing the disease. Imported manufactured products from these materials—for instance bone meal—could also constitute a risk. There is no indication that any such materials or their products have been responsible for outbreaks of the disease in Great Britain since 1938, that is, in the period for which detailed records are available. This may be because the climatic conditions in the exporting countries, the delays that occur before materials can come into contact with animals, and the manufacturing processes are all conducive toward the destruction of the virus.

(iv) *Semen*

19. It has been demonstrated experimentally that foot-and-mouth disease virus can be present in bull semen before the infected animal has shown clinical signs and that infected semen can give rise to the disease in an inseminated cow. Thus semen may be a source of infection to other animals. The practice of storing semen at low temperatures is conducive to survival of the virus. However, the risk of introducing the virus into a country, or of spreading the virus within a country by means of infected semen is not considered great.

(v) *Glandular products*

20. Biological substances prepared from the glands of infected animals may be contaminated by foot-and-mouth disease virus. The virus could be passed to susceptible animals which were being treated with such substances. In 1938 an outbreak in Great Britain was traced to a contaminated imported glandular product used in the treatment of a cow but there have been no recorded cases since then in this country.

(vi) *Hay, straw and other vegetable matter*

21. Hay and straw are recognised as potentially dangerous materials. Foot-and-mouth disease virus has been shown experimentally to survive on hay for at least 15 weeks, on bran for 20 weeks, and on straw for 4 weeks. Outbreaks of disease in Switzerland have been ascribed to contaminated vegetable matter; there was a remote possibility that an outbreak in Great Britain in 1951 was due to imported bulbs with which cattle might have had contact.

22. The second Pretyman Committee Report (Cmd. 2350) attributed an outbreak to swill which contained parings from imported vegetables. The Gowers Committee found no evidence of this in the period 1938–1953 and outbreaks have not been so attributed subsequently. There was general agreement among our expert witnesses that the risk of introducing the virus into Great Britain with imported vegetable matter is insignificant.

(vii) *Hides*

23. Foot-and-mouth disease virus has been shown to survive for long periods on raw and cured hides. The experience in this country suggests that hides are not a hazard since no origins for primary outbreaks have been attributed to them in the period since 1954. The time taken to transport hides to this country and the urban siting of factories probably minimise the risks. The Nene Valley in Northamptonshire—a main leather processing area—has had a very low incidence of foot-and-mouth disease over the past thirty years.

(viii) *Passenger traffic*

24. Spread of foot-and-mouth disease from a primary outbreak has on a number of occasions been attributed to the movement of people who have been in contact with infection, and this will be dealt with fully in Part II of our Report. We also found widespread recognition of the hazard of introducing the disease through foreign travel and by visitors from overseas. With modern fast travel by land, sea or air and the growing mobility of populations this risk is increasing (see also paragraph 140). The foot-and-mouth disease virus can be carried by people on their skin, clothing, shoes and luggage. Experiments have shown that the virus can survive on clothing for periods of from eighty to a hundred days. Tourists in rural areas, farmers and livestock buyers from foreign countries are among those who might inadvertently carry the virus. There have been two incidents in the past where the introduction of foot-and-mouth disease was attributed to the movement of persons between countries. One occurred in 1937 when workers were presumed to have carried the disease to Yugoslavia from France. The second was in Canada in 1952 when the virus was presumed to have been carried to that country from Europe with an immigrant's effects, possibly on his working overalls or in a meat product. We do not consider this risk to be great; a number of countries which remain free of foot-and-mouth disease receive many visitors from countries where the disease is prevalent.

(ix) *Vehicular traffic*

25. Vehicles that have carried infected animals or have been on infected premises can play a part in the spread of foot-and-mouth disease from a primary outbreak. They may also carry infected material from one country to another (see also paragraph 141). The length of time that foot-and-mouth disease virus would remain viable on a vehicle would depend on the nature of the infected material adhering to the vehicle and on many other factors. It has been shown experimentally that the virus can survive at temperatures of 59 °–68 °F for two to three days in blood dried on iron, for at least two weeks on wool and four weeks on cow hair.

(x) *Wind*

26. The possibility that foot-and-mouth disease virus might be transmitted by the wind has been recognised for a long time. The Gowers Committee were able to point out that the virus could be carried through the air for short distances. They also reported that the veterinarians in Scandinavia were convinced that this was the commonest way in which infection reached their countries. Danish experience supported the theory of windborne infection, and there was an absence of other plausible explanations for the manner in which the virus had spread to Scandinavian countries from Germany.

27. Since 1954 there has been further evidence in support of the theory that foot-and-mouth disease virus is transmitted in air currents. Recent evidence from Denmark suggests that the virus can be windborne for up to eighteen miles over the sea and, in exceptional circumstances, over twice that distance. Danish veterinary officials thought that windborne infection, associated with darkness and damp weather, was the most frequent cause of primary outbreaks in Denmark.

28. In Great Britain much work has been done by the Meteorological Office and the Ministry of Agriculture to examine the general hypothesis that meteorological conditions could have favoured the spread of the virus from Continental sources on the occasion of past outbreaks of the disease in Great Britain, and to assess the effects of meteorological conditions on secondary spread in this country. An examination by the Meteorological Office of all primary outbreaks since 1937, except the minor ones, has shown that in every case of multiple and simultaneous outbreaks on the south and east coasts, suitable wind tracks could be found leading back to known infected areas in Europe. It was noted that in the area of the outbreaks, rain, which could have precipitated the virus, occurred at the relevant time. An alternative interpretation by the Microbiological Research Establishment was that the outbreaks could be better accounted for by the favourable effects on the viability of the virus of the high relative humidity prevailing at the time.

29. The Meteorological Office also examined the effect of meteorological conditions on secondary outbreaks of the disease. This was done in five areas: Cheshire (1952); Shropshire (1961); Northumberland (1966); Hampshire (1967); and Cheshire (1967). (The last of these studies had advanced to the point of examining those outbreaks during the initial stages of the epidemic for which there were very few possible authenticated sources; further work is in progress.) The results of the examination suggested that wind and rain might have played a part in the spread of the disease. In general the examination showed that—

(i) few outbreaks occurred upwind of a known source;

(ii) outbreaks were limited to about $2\frac{1}{2}$ miles downwind in dry weather;

(iii) outbreaks extended further downwind in wet weather and even further in periods of light rain;

(iv) most outbreaks were downwind of more than one possible source of infection on several occasions during rainy periods;

(v) selecting the most likely sources of infection, the percentages of total outbreaks downwind, in relation to distance, were as follows-

33 per cent within $1\frac{1}{4}$ miles
60 per cent within 3 miles

75 per cent within 6 miles
85 per cent within $12\frac{1}{2}$ miles
90 per cent within $18\frac{1}{2}$ miles
95 per cent within 31 miles

(these percentages did not include the Cheshire 1967 epidemic);

One case might have been associated with airborne spread of the virus at a distance of 50 miles;

(vi) in all five areas there was a number of secondary outbreaks during the second week following the primary infection; after dry weather the number was low and after wet weather it was high;

(vii) in all five areas there was a decline in the number of new outbreaks during a period of dry weather.

The Meteorological Office concluded that the amount of spread due to meteorological causes could be as high as 95 per cent and was unlikely to be less than 80 per cent. They also concluded that spread did not occur unless favourable wind and rain conditions prevailed.

30. The evidence suggests that viruses contained in airborne particles will travel in a viable form in the air for distances of up to thirty miles or more depending on the particle size, the strength of the wind and other factors. Theory and experience suggest that the relevant range of suitable particle size is from 2 to 10 thousandths of a millimeter (2 to 10 microns). The degree of upward mixing of particles depends on meteorological and topographical factors. Transmission of airborne virus by night appears to be a greater threat than by day because of the absence of ultra-violet light. The Microbiological Research Establishment suggested that there may be other influences at work in the survival of foot-and-mouth disease virus about which conclusive answers are not at present available. For example, some viruses are known to survive better in association with large particles rather than small ones. Atmospheric relative humidity is a very important factor; high relative humidity appears to prolong the survival of viruses in aerosols. The salt and protein content of the material in which viruses are conveyed and the extent of atmospheric pollution might exert an influence on survival. Although heavy rain may aid deposition of viruses, experiments suggest that it may clear the atmosphere of noxious substances deleterious to the viruses and so prolong their survival.

31. The release of foot-and-mouth disease virus into the air may be brought about in many ways. Present work at the Animal Virus Research Institute on the presence of the virus in the air of animal houses containing infected animals shows that the amount of excreted virus is fairly uniform, starting before the vesicles appear and continuing thereafter. Movement of infected animals or the disturbance of infected materials could create an aerosol containing the virus. Animals either housed or at pasture can be infected by inhalation of airborne virus. It has been suggested that the virus may be drawn up into the air and carried to other sites in thermal air currents generated when infected carcases are burned. In this case the virus source might not be confined to the carcases; contaminated dust particles from the ground surrounding the pyre might also be drawn up into the air and carried away by the wind. During the 1967/1968 epidemic in the west Midlands large volumes of air were sampled at points 100 and 300 yards downwind from fires used to destroy

THE FOLLOWING SIX COLOUR PHOTOGRAPHS SHOW TYPICAL CLINICAL SIGNS PRESENT IN ANIMALS AFFECTED WITH FOOT-AND-MOUTH DISEASE.

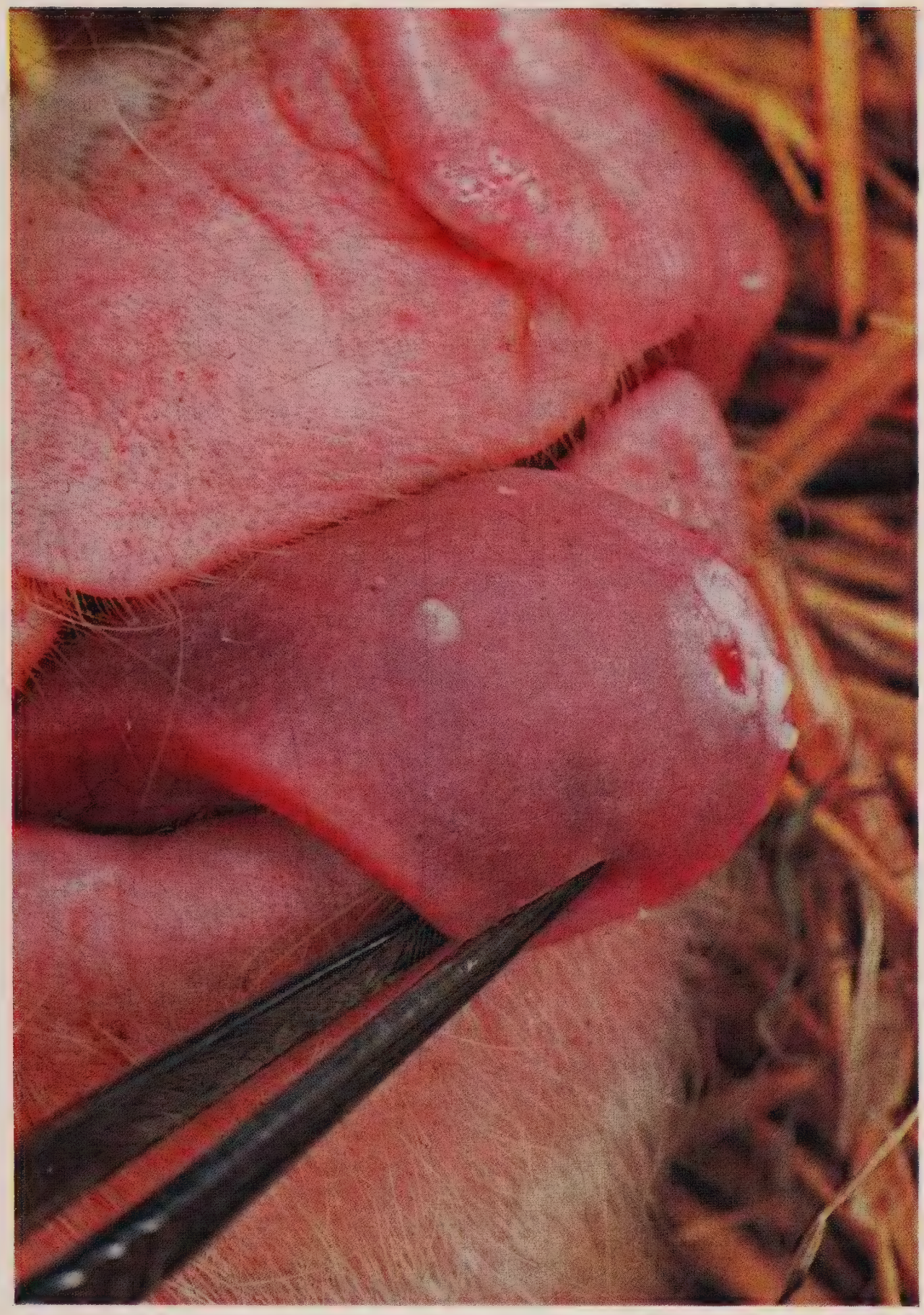
This shows a ruptured blister on the top of the front of a steer's tongue, and shows the ragged appearance of the broken "skin"; two pieces of "skin" have been removed and laid on the animal's upper lip. There is extensive separation of the "skin" from the tissue beneath and the typical raw base of the ruptured blister is clearly visible.

This shows a ruptured blister on the edge of the right side of a steer's tongue, some of the " skin " has been removed and laid at the side of the blister. The blanched area of " skin " to the right of the ruptured part of the blister shows the extent to which the " skin " is separated from the tissue beneath.

This shows a teat of a cow with a large ruptured blister. There is a considerable area denuded of skin, and in places the skin is partly detached from the tissue beneath. Most of the base of the ruptured blister is healing and has lost its raw appearance.

This shows a ruptured blister on the foot of a sheep at one side of the front of the space between the hooves where the horn and skin meet.

This pig's foot shows blisters as blanched areas at the junction of horn and skin on the heels of the main digits and extending some distance up the back of the accessory digits. The blister on the left main digit has ruptured and lost some of its skin at its outer edge to reveal the raw base. On the left accessory digit the skin has been lost in two places following rupture of the blister.



This shows blisters on the snout and tongue of a pig. There is an unruptured blister on the right side edge of the snout. At the front of the tongue there is a ruptured blister showing the raw base with the area of blanched and separated " skin " at its edges; further back there is a smaller unruptured blister with its blanched " skin ".

carcases on two farms. No virus was isolated from the samples but it was thought that the efficiency of the technique employed might not have been high enough to give significant results.

32. Airborne particles can be deposited from the atmosphere by gravity, by downward diffusion of air, by impaction on a solid object or in a falling raindrop. Large particles (greater than 10 microns) will be deposited close to the source of infection. Virus deposited on pasture or fodder can cause infection when ingested. Smaller particles, on the other hand, will travel in an aerosol and be little affected by gravity or rainfall (other than very heavy rainfall). The probability of infection by inhalation will depend on the concentration of virus-containing particles in the air. It will also depend on the viability of the virus which will be influenced by a number of factors, the most important probably being relative humidity.

33. It has been suggested that animals at free range are exposed to a greater risk from windborne foot-and-mouth disease virus than animals that are housed. On the other hand if buildings are close to a source of infection they may act as a trap for windborne virus, and animals inside may then be at a greater risk than when they are outside.

(xi) *Birds*

34. It is possible that birds are responsible for the introduction of foot-and-mouth disease into countries and for its subsequent spread. It is known that the foot-and-mouth disease virus can be conveyed on the feet or feathers of birds and can be excreted by them after ingestion of material contaminated with the virus, but there is no evidence that birds can become infected with the virus. The Gowers Committee pointed out that the virus had been recovered from the feet and feathers of a bird contaminated experimentally as long as 91 hours after contamination. Also it was reported that starlings given the virus by mouth had excreted it in their faeces for a period of 10-26 hours. It is thus probable that birds may spread the virus and so cause secondary outbreaks. They are likely to constitute a greater risk if they are carrion eaters such as crows and seagulls. In the recent past there has been considerable misgiving about attributing primary outbreaks to bird migration and it has been suggested that many of the outbreaks so attributed may have been due to windborne virus. Recent Danish evidence suggests that some of the outbreaks previously presumed to have been associated with bird migration to that country cannot be related to migration patterns.

(xii) *Milk and milk products*

35. Foot-and-mouth disease virus may be present in milk from infected cows a few days before clinical signs appear and may persist for a long time afterwards; milk containing the virus could therefore leave a farm before disease was even suspected. Thus milk presents a major potential hazard in transmission of the disease not only by direct transference but also through the contamination of persons, containers and vehicles (see also paragraph 95).

36. Foot-and-mouth disease virus present in milk can be destroyed by varying combinations of time and temperature; an increase in the acidity associated with souring of milk increases the rate of viral destruction. The pasteurisation process used for the treatment of liquid milk may be inadequate to destroy

the virus completely; the virus may also persist in milk for cheese making and in skim milk for animal feeding. Thus such products, if infected, could play a part in the spread of the virus (see also paragraphs 94 and 95). Recent work has shown that the virus in milk from an infected cow is much more difficult to destroy than virus which has been added to milk in the course of an experiment.

(xiii) *Domestic and wild animals*

37. Domestic and wild animals such as dogs, cats and foxes may act as mechanical carriers of foot-and-mouth disease virus, especially the carrion eaters. The extent of the risk will depend on the habits of the different species. Rats may be an even greater risk in transmitting infection since they may carry the virus in their gut for long periods. Naturally occurring disease in hedgehogs is well authenticated but the disease produces lameness and they do not travel far when infected. On the other hand the hibernation of hedgehogs might be the means of reviving infection after the lapse of a considerable period of item (see Appendix II). Deer may also become infected naturally as well as acting as mechanical carriers, but they have not been associated with any outbreaks in Great Britain in this century. In some countries wild ruminants and wild pigs are important as sources of infection and in spreading the disease.

(xiv) *Insects and arthropods*

38. It has been shown experimentally that flies and ticks may transmit foot-and-mouth disease virus from infected to susceptible animals. The virus may survive for long periods in ticks and in their excreta.

(xv) *Watercourses and effluents*

39. The extent to which streams, rivers and effluents act in spreading foot-and-mouth disease virus is unknown but it can survive in water for a time sufficient for it to be conveyed to neighbouring land by a stream. This is a possible means of spread which might be further investigated.

(xvi) *Technical developments in agriculture*

40. The pattern of the livestock industry in many countries has changed markedly over the last ten years; in Great Britain for example there has been a reduction in the number of dairy units and a rise in the number of dairy cattle. It was suggested that the number of closed herds may have been declining, with the result that herds are less self contained than they used to be. On the other hand there are indications that the number of closed herds may not be altering significantly; the situation is bound to vary from time to time with changing agricultural policy. Any increasing movement of animals, and other practices associated with intensive farming, such as dung and slurry disposal and bulk milk collection, may well be new factors favouring the spread of foot-and-mouth disease.

(xvii) *Excretion of the virus by infected animals*

41. An important feature of the disease in relation to its spread is the early excretion of the virus from an infected animal before the onset of clinical signs. Excretion for 24 to 48 hours before the appearance of lesions has long been

accepted but experiments carried out at the Animal Virus Research Institute in 1967 indicate that longer periods of viral excretion may occur. The experiments were made with the 0_1 prototype strain of virus, British Field Strain 1860 (BFS. 1860), isolated from the 1967/1968 epidemic. This work showed that the virus was excreted for a maximum of five days in cattle and sheep and ten days in pigs before the onset of clinical signs. (The experiment is discussed in detail in paragraphs 87 to 89). This earlier excretion is not necessarily a feature associated only with the BFS. 1860 strain; it was demonstrated by the application of new techniques which had not been applied previously. It was pointed out by some of our witnesses that as the evidence relating to early excretion of virus was based on laboratory findings, it might not necessarily apply to the same extent in field conditions. However we consider that the excretion of virus can be a significant factor in spread for at least three days before the onset of clinical signs in cattle, and probably for a longer period in pigs.

(xviii) *Carriers*

42. A further significant feature of the foot-and-mouth disease virus is the ability to persist in the convalescent animal, or in the immunised animal exposed to infection without the animal showing any clinical signs of disease. Such animals are referred to as " carriers ", and the virus can be isolated from them. There would thus appear to be a theoretical risk of such animals spreading the disease but there is little evidence that this takes place in the field.

43. At the time of the Report of the Gowers Committee the possibility that vaccinated animals might undergo a mild form of the disease and become carrier animals was recognised, although there was little information about the nature and incidence of the so-called ' masked infection ' that would then occur. The introduction of general vaccination policies in many countries has made it difficult to study the carrier state in the field, and apart from experimental evidence we have been restricted to reviewing classical observations where carriers might have been expected to occur. An Australian incident associated with the export of bulls from the United Kingdom in 1871/1872, which has been quoted as an instance of carrier transmission, has recently been reviewed by Dr. Murray Puller (Veterinary Research Institute, University of Melbourne), and he suggests that other factors may readily have been responsible. In the U.S.A. in 1914/1915, 740 animals that had either been infected or in contact with foot-and-mouth disease in a show yard were, after a period of isolation, placed in contact with young susceptible cattle and pigs. These young animals remained free of the disease even after a protracted exposure. In an extremely severe epidemic in Denmark in 1938/1939 where some 50 per cent of all cattle were infected, there was no sign that recovered animals subsequently played any part in the spread of the disease. There is some evidence, however, from studies carried out in Africa that animals which had recovered from foot-and-mouth disease many months previously may have infected susceptible animals. Other reported outbreaks attributed to carriers are not sufficiently scientifically documented for reappraisal.

44. Since 1954 further information has been obtained on the carrier state as a result of investigations by several groups of research workers at the Animal Virus Research Institute, on the Continent, at the Centro Pan Americano de Febré Aftosa (Pan American Foot-and-Mouth Disease Center) in Brazil and at

the Plum Island Animal Disease Laboratory of the United States Department of Agriculture. Their findings may be summarised as follows:

(*a*) both fully susceptible and immunised cattle may become carriers after experimental infection;

(*b*) the virus can be shown to be present in carriers in the mouth, pharynx, oesophagus and the tonsils (the last especially in sheep);

(*c*) over a period varying from up to a few months to two years after initial infection, the virus can be recovered from the pharynx and oesophagus by taking samples of mucus with the aid of an instrument known as a probang;

(*d*) susceptible animals kept in close contact with proved carrier animals did not develop clinical signs of the disease nor was the virus isolated from them;

(*e*) there is some evidence that in a small number of cases, the virus may pass from carrier animals to susceptible animals; this is suggested by the presence of foot-and-mouth disease antibody in a few susceptible animals after exposure to carriers and by one of them resisting challenge with foot-and-mouth disease virus;

(*f*) properly inactivated vaccine, when injected into animals, does not of itself give rise to the carrier state.

45. The consenus of opinion among our scientific witnesses was that the danger of carrier animals had been exaggerated and that carriers in a susceptible population did not constitute a significant risk. (See paragraph 124 for more recent Danish experience.) In this context we quote the European Commission for the Control of Foot-and-Mouth Disease* who have stated that " From the material that has been collected and surveyed it would seem that only in exceptional cases are recovered animals able to transmit foot-and-mouth disease and therefore would seem to play a very small role in the epizootiology of the disease ".

* " Review of Epizootiology and Control of Foot-and-Mouth Disease in Europe 1937 to 1961 ".

CHAPTER III

THE WORLD DISTRIBUTION OF FOOT-AND-MOUTH DISEASE

46. The Report of the Gowers Committee reviewed the distribution of foot-and-mouth disease during the years 1929 to 1953 both at home and overseas. Briefly the position abroad was that the disease had never been known in New Zealand; Australia had not had an outbreak since 1872; the U.S.A. had enjoyed freedom for 25 years and Ireland for thirteen years. Canada had experienced only one outbreak which occurred in 1952. In the greater part of South America, throughout Asia, in most African countries and in most of Europe, the disease was either endemic or sporadic with occasional epidemics.

47. The position in Australia, Canada, Ireland, New Zealand and the U.S.A. has not altered. We do not have complete information on the world distribution of foot-and-mouth disease but a number of countries provided us with information (see Appendix I). Table I shows the number of outbreaks in the countries that made returns to the Office International des Epizooties (O.I.E.) for the year 1967. Table II shows their populations of livestock that are susceptible to foot-and-mouth disease.

TABLE I

Outbreaks of Foot-and-Mouth Disease in Foreign Countries in 1967, reported to O.I.E.

Country	Reported Outbreaks	Country	Reported Outbreaks	Country	Reported Outbreaks
Algeria	33	Hungary ..	4	South West Africa ..	1
Angola	38	India	3,438	Spain	305
Argentina ..	4,634	Iran	281	Sudan	3
Belgium	22	Iraq*	72,039	Syria	293
Brazil	116	Italy	211	Tanzania ..	171
Cambodia.. ..	1	Jordan	33	Thailand ..	248
Cameroon ..	42	Kenya	174	Togo	1
Ceylon*	18,465	Lebanon ..	308	Tunisia	2
Colombia* ..	232	Malawi : ..	2	Turkey	2,068
Dahomey	30	Mozambique ..	1	U.S.S.R. ..	3,323
Denmark	5	Netherlands ..	196	U.A.R. (Egypt)*	252
East Germany ..	66	Poland	10	Upper Volta ..	14
France	17	Portugal ..	520	Uruguay* ..	53
Federal Republic of Germany ..	3,350	Rhodesia ..	1	Venezuela ..	68
Greece	58	South Africa ..	8	Vietnam.. ..	1

* Reported cases.

TABLE II

Populations of Susceptible Livestock in the Countries listed in Table I (1967) (million head)

Country	Cattle	Sheep	Pigs	Goats	Buffaloes
Algeria	0·540	6·250	0·072	2·650	—
Angola	2·117	0·135	0·312	0·478	—
Argentina	51·227	49·000	3·000	5·200	—
Belgium	2·759	0·165	2·383	0·024	—
Brazil	84·000	21·877	59·000	13·815	—
Cambodia	2·290	—	1·130	—	0·860
Cameroon	1·850	0·300 (inc. goats)	0·300	(see sheep)	—
Ceylon	1·910	0·034	0·120	0·630	1·100
Colombia	15·019	1·710	1·878	0·400	—
Dahomey	0·390	0·460	0·339	0·570	—
Denmark	3·374	0·112	8·120	—	—
East Germany	4·700	2·050	8·800	0·330	—
France	20·300	9·055	9·149	1·014	—
Federal Republic of Germany	13·981	0·810	19·032	0·089	—
Greece	1·100	8·980	0·650	3·800	0·038
Hungary	2·014	3·270	6·005	—	—
India	188·800	44·410	5·500	67·200	56·539
Iran	4·900	30·000	0·050	13·000	0·250
Iraq	1·510	11·250	—	1·800	0·225
Italy	9·600	7·900	5·450	1·225	—
Jordan	0·072	0·987	—	0·759	—
Kenya	7·242	5·375	0·031	6·400	—
Lebanon	0·105	0·289	—	0·430	—
Malawi	0·410	0·083	0·140	0·483	—
Mozambique	1·135	0·099	0·127	0·457	—
Netherlands	4·030	0·529	4·295	—	—
Poland	10·767	3·321	14·233	—	—
Portugal	0·904	5·029	1·492	0·521	—
Rhodesia	4·144	0·554	0·122	0·903	—
South Africa	12·500	37·900	0·898	5·394	—
South West Africa	2·330	3·760	0·020	1·595	—
Spain	3·914	16·647	6·823	2·448	—
Sudan	7·500	8·660	—	6·854	—
Syria	0·507	5·400	—	1·405	0·002
Tanzania	10·549	2·666	0·021	4·372	—
Thailand	5·300	—	4·300	—	6·900
Togo	0·173	0·640	0·235	0·537	—
Tunisia	0·600	3·800	0·002	0·500	0·454
Turkey	12·650	32·654	—	21·162	1·202
U.S.S.R.	97·100	138·300	50·800	5·600	—
U.A.R. (Egypt)	1·630	1·930	—	0·790	1·650
Upper Volta	2·400	1·150	0·130	2·000	—
Uruguay	8·680	21·293	0·259	—	—
Venezuela	6·702	0·071	1·931	1·237	—
Vietnam	1·100	—	3·473	—	0·733

The disease was also present in 1967 in Burundi, the Congolese Republic, Djibouti, Ghana, Israel, Libya, Paraguay, Republic of Niger, Republic of Nigeria and Uganda, but we do not know the total number of outbreaks. The following countries advised O.I.E. that they had been free from the disease in 1967:

Albania	Czechoslovakia	Hong Kong	Rumania
Austria	Ethiopa	Lesotho	Sweden
Botswana	Finland	Malaysia	Switzerland
Bulgaria	Gaboon	Morocco	Yugoslavia
Cyprus			

It was also reported that the disease does not occur in Jamaica, Madagascar and the New Hebrides, and that Japan has not had an outbreak since 1933. Map I shows the distribution of the types of virus throughout the world since 1954. The present situation is briefly discussed in the following paragraphs.

Africa

48. Foot-and-mouth disease is endemic in parts of the African Continent. An important contributory factor to the continued presence of foot-and-mouth disease virus in African countries is the presence of wild animals. For instance when the disease occurs in some border regions of Rhodesia it is sometimes associated with migrations of game from Botswana in the west and from Mozambique in the south-east. Outbreaks of the disease which originate in wild animals often appear to have been smouldering there for some time, and indeed strains of the virus have been found which seem to be adapted preferentially to particular species of game. The veterinary authorities in some African countries, for example South Africa, have made determined efforts to restrict the spread of the disease by fencing off some of the game areas. Many African countries are now promoting vaccination schemes.

South America

49. Foot-and-mouth disease is endemic in many areas of South America. The Pan American Foot-and-Mouth Disease Center, which operates under the Pan American Health Organisation, advises on control programmes and a number of countries have embarked on systematic vaccination campaigns. Argentina, Brazil and Uruguay have already established extensive vaccination programmes and a number of other countries are developing schemes. We visited Argentina, Brazil and Uruguay and were impressed by the progress that is being made in controlling foot-and-mouth disease in those countries. The disease situation in Argentina is progressively improving. The Province of Santa Cruz and the territory of Tierra del Fuego appear to be free from foot-and-mouth disease, and if outbreaks occur they would be dealt with by the slaughter policy. Plans are in hand for extending this policy to the Provinces of Chubut and Rio Negro, and a buffer zone is maintained between the Rio Negro and the Rio Colorado, in which all cattle, sheep and pigs are vaccinated, to protect the disease-free area to the south. We would expect that the vigorous pursuit of their policies will lead to the gradual isolation and then the extension of disease-free areas in all three countries.

North and Central America

50. The U.S.A. and Canada have been free for many years from foot-and-mouth disease; the last outbreak in Canada was in 1952 and in U.S.A. in 1929—both outbreaks were eradicated by slaughter. Central America has been free of the disease for some time. The Pan American Health Organisation controls the entry of all animals, vehicles and travellers entering Panama from the South American Continent, and there is a zone across the Darien Peninsula in which there is a restriction on movement of cattle. Most of the large Caribbean islands are free; the last outbreaks were in Curaçao in 1961 and in Guadeloupe in 1964. There was a serious outbreak in Mexico in 1948 which was eradicated (see paragraph 122); the country has been free of the disease since 1953.

World distribution of types of Foot and Mouth Disease Virus
1954 – 1968

Map I

Source: Animal Virus Research Institute

Oceania

51. Foot-and-mouth disease has never been known in New Zealand. Australia has been free of the disease since 1872.

Asia and the Sub-Continent of Asia

52. In large areas of South-East Asia and the Sub-Continent of Asia foot-and-mouth disease is endemic. We have no precise information about the disease in China but Japan has been free since 1933. In the Middle East sporadic disease occurs from time to time and the disease is endemic in certain areas.

U.S.S.R., Central and South-East Europe

53. Foot-and-mouth disease is reported to be sporadic in European U.S.S.R. but endemic in the cattle raising areas of Central Asia. It is said to be present in wild animals in these areas and in adjoining countries. Outbreaks occur from time to time in the Balkans and in Central Europe and may at times give rise to epidemics. The disease appeared in Rumania in 1959 and spread to the neighbouring countries of Bulgaria, Yugoslavia and Hungary. About the same time outbreaks occurred in Poland and Finland. By 1960 Rumania and Bulgaria, and by 1961 Yugoslavia, were once again free of the disease but sporadic outbreaks have occurred since. By agreement with Czechoslovakia, Poland and Rumania, the U.S.S.R. maintains buffer zones of vaccinated stock along its frontiers with these countries and in some areas zones about nine miles wide are kept free from all susceptible livestock for additional security. Bulgaria continues to vaccinate in its border area adjoining Turkey as part of the campaign to protect south-eastern Europe against types of virus from which Europe is generally free. (In paragraph 121 we describe the measures that were taken from 1962 onwards to fight the spread into Europe of South African type SAT. 1 virus and of type A_{22} virus which spread through Turkey and the Anatolian Peninsula as far as Greece.)

Western Europe

54. Table III gives the incidence of foot-and-mouth disease from 1954 to 1968 in the European countries nearest to Great Britain. Outbreaks in Great Britain are also shown, for the purpose of comparison. Luxembourg, Northern Ireland, Norway and the Republic of Ireland have had long periods of complete freedom from the disease. In the remaining countries mentioned in the table, outbreaks of the disease have occurred regularly in most years, and during some periods a number of countries such as France, the Federal Republic of Germany, Italy, Portugal and Spain have suffered heavy attacks. Among more distant countries not included in the table, Finland has been free since 1959 and Sweden since 1966. The disease has never been introduced into Iceland. Vaccination has been used to control outbreaks of the disease in some European countries since about 1939, and by 1960 countries such as France and the Netherlands had developed and were applying general prophylactic vaccination programmes. These programmes, together with the slaughter policy, have greatly reduced the general level of infection in Western Europe over the last few years. This is especially evident in France where there was a steep fall in the number of outbreaks after 1961.

TABLE III

Incidence of Foot-and-Mouth Disease in some European Countries, 1954–1968

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Austria	0	0	37	108	0	6	1	0	0	59	0	34	22	0	0
Belgium	700	195	693	328	568	57	180	121	6	67	2	112	323	22	1
Denmark	43	43	6	45	11	1	1	22	0	23	4	2	39	5	5
Federal Republic of Germany	481	257	1,401	6,383	1,265	118	1,395	6,989	11,359	7,700	5,342	15,944	4,689	3,350	68
France	838	2,451	6,800	99,424	14,127	6,188	7,382	2,626	199	28	56	10	59	17	40
Italy	6,450	12,635	5,890	7,394	6,453	11,764	11,547	18,272	5,237	5,114	12,372	5,842	1,559	210	22
Luxembourg	4	0	18	2	0	0	0	0	0	6	0	0	0	0	0
Netherlands	34	48	47	40	11	6	3	179	5,470	2,103	146	1,426	2,194	196	0
Northern Ireland ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	3	0	41	37	3,912	1,489	53	1	0	0	2,018	770	17	520	910‡
Republic of Ireland ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	5,189*	924*	9,254*	17,839*	226,597*	89,191*	11,259*	21†	0	3	5,607	1,303	29†	305	561
Switzerland	5	3	121	111	53	13	96	141	133	144	68	671	321	0	23
Great Britain	12	9	162	184	116	45	298	103	5	0	0	1	34	2,210	187

Note: The figures above show numbers of outbreaks, with the following exceptions.
*=Number of animals affected.
†=Villages or municipalities affected.
‡=Up to September.

Source: (1954-1967) Reports of the European Commission for the control of Foot-and-Mouth Disease.
(1968) Ministry of Agriculture

CHAPTER IV

FOOT-AND-MOUTH DISEASE IN GREAT BRITAIN

(*a*) General

55. Foot-and-mouth disease is not endemic in Great Britain where the latest returns show a susceptible livestock population of about 44 million. Figures I and II illustrate the prevalence of the disease in the period 1954–1967 and the relationship of primary outbreaks to secondary spread.* There was a period of complete freedom from the disease from June, 1962 to March, 1965 and over the years there have been long intervals between individual outbreaks stemming from each of the three main virus types.

56. The slaughter policy adopted in Great Britain has resulted in an entirely susceptible livestock population and if foot-and-mouth disease virus were continually present in the country more frequent outbreaks would undoubtedly have occurred. Further, there is an annual importation of about 400,000 Irish store cattle and a relatively small number of store sheep which are widely distributed to farms in Great Britain, and the fact that these susceptible animals do not develop the disease is also an indication that it is not endemic in Great Britain.

(*b*) 1954—September 1967

57. In reporting on the situation at home, the Gowers Committee was unable to point to any single year in the period from 1929 to 1953, over which their review extended, in which the country had been completely free from foot-and-mouth disease; the last period of complete freedom had been in 1917. Outbreaks occurred in each of the years from 1954 to 1960, and in four of these years reached fairly high levels. The high incidence of disease persisted into 1961 with 101 outbreaks from 1st January to 15th April of that year. By contrast, the years from late 1961 to mid–1966 saw a record low level of disease. There was only one outbreak in the last half of 1961, and five in the first half of 1962 of which two were primaries; and thereafter the country remained completely free from the disease until April, 1965 when an isolated outbreak occurred in Kent. This was followed by fourteen months freedom until July, 1966, when the disease broke out in Northumberland; the virus type was O_1. The affected district was heavily stocked with grazing cattle, and 250,000 breeding ewes and lambs were on open grazings nearby. If the disease had reached the open grazings a very large number of sheep might have become infected and the disease might have spread into Scotland and southwards along the Pennines. In the event, a large Infected Area† was declared and in several instances stock were slaughtered on farms adjoining the infected premises in order to establish a buffer zone devoid of stock to protect the free range grazings. The disease was successfully confined to two fairly small districts within the

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* A primary outbreak is one that cannot be linked with any known source of infection in livestock in Great Britain and is therefore attributed to the virus having been introduced from abroad. Secondary outbreaks are those which arise from a spread of infection from primary outbreaks or previous secondaries.

† An Infected Area is an area defined by Statutory Order in which movements of animals and the holding of markets are prohibited except under licence.

Infected Area and did not spread to other counties. In all, the disease was confirmed on 32 farms; 5,753 cattle, 38,448 sheep and 714 pigs were slaughtered.

58. Towards the end of September, 1966 there was a primary outbreak in Sussex, with one secondary, involving type A_{22} virus which was the virus type responsible for the epidemics in the Near East at that time. No connexion could be traced, however, between the Sussex outbreak and any external source.

59. On 8th January, 1967 a primary outbreak in pigs in Hampshire (type 0_1 virus) resulted in 28 secondary outbreaks over a period of four weeks. Five of these were linked with a local abattoir where pigs from infected premises had been sent for slaughter. Between 4th and 7th September four other outbreaks were confirmed at Stratford-on-Avon in Warwickshire (see also paragraph 62) and again the virus type was 0_1.

60. The general improvement in the years 1961–1966 coincided with a period of marked reduction in the level of infection in Belgium and France. But it also coincided with an unusually high incidence of the disease in the Netherlands and the Federal Republic of Germany (see Table III).

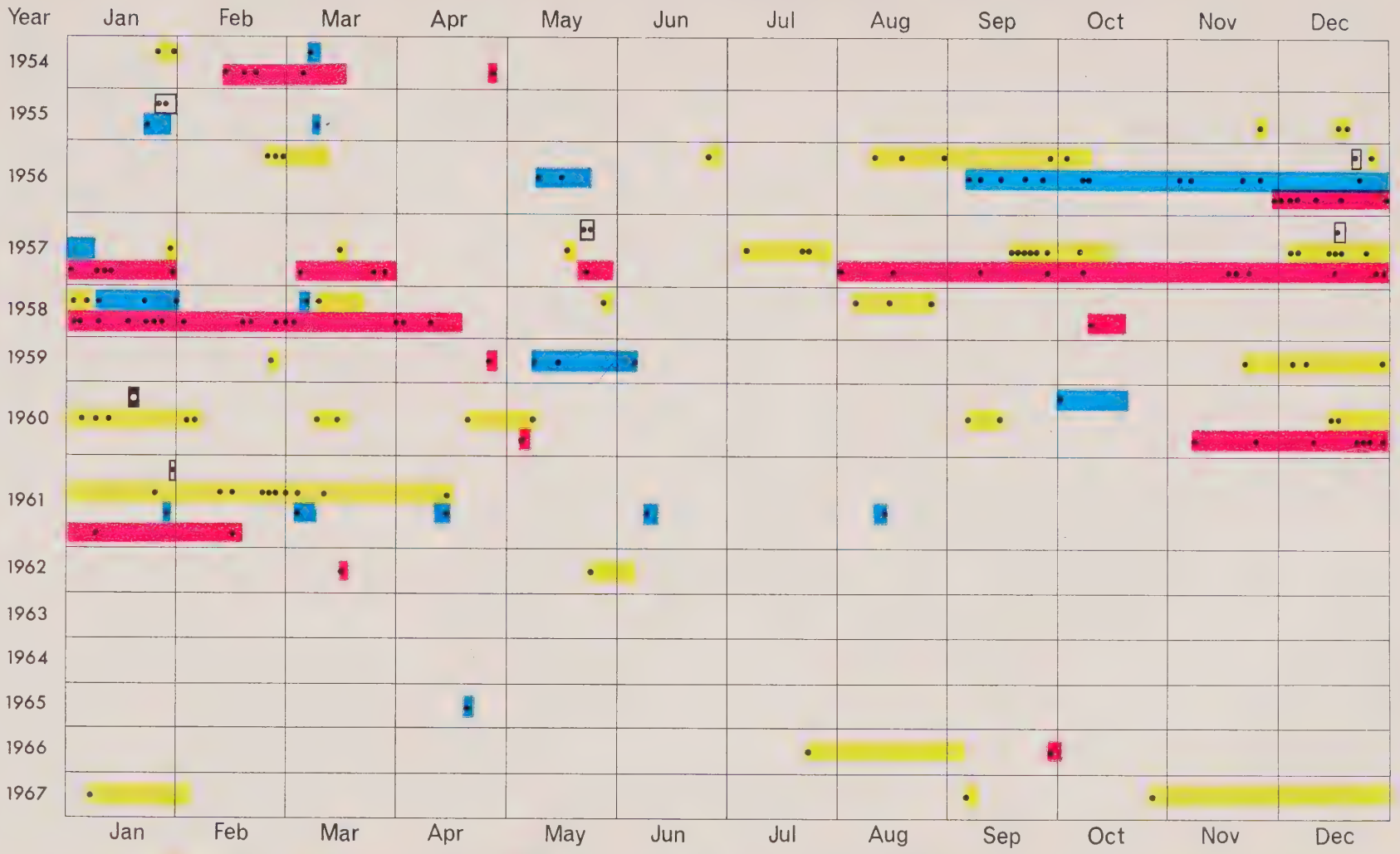
61. Notwithstanding the general improvement from 1961–1966 there were episodes in Great Britain in the period under review which presented alarming characteristics. An outbreak in cattle in the Forest of Dean, Gloucestershire in 1956 involved common grazings and although free-ranging stock were at once brought into enclosures, the movements of sheep and the communal dipping which had already taken place led to widespread infection. In 1957 there was an outbreak in pigs on a farm in Caernarvonshire where the disease had been present for several days before it was confirmed. Hundreds of owners, many of whom kept small numbers of pigs, had their stock slaughtered because of the risk of contact with the disease. The Infected Area embraced mountainous, unfenced country, including Snowdonia, but fortunately the disease did not reach the mountain sheep. There was a unique outbreak in mid-January, 1960 on a farm in Surrey adjoining the Animal Virus Research Institute at Pirbright. The virus was of a South African type which had apparently escaped through the Institute's ventilation system to fields surrounding the inner compound; it was thought to have been spread to the farm by birds or by other wild life. There was no secondary spread from this one primary outbreak. In November, 1960 a primary outbreak, which occurred on a farm in Northumberland, was not detected until the infected animals had reached a slaughter-house in Durham. A large number of subsequent outbreaks was attributed to movements of cattle through markets and slaughter-houses, and the disease spread to Scotland for the first time in seven years.

62. In the period 1954–1967, the disease was diagnosed in 86 per cent of all outbreaks when lesions in the animals were estimated to be less than two days old, and in 71 per cent when lesions were estimated to be less than a day old. From 1959 to October, 1967, however, there were 17 outbreaks where the animals had lesions over seven days old before the disease was confirmed. Of these 17, five had not been reported and were found when the Ministry of Agriculture was carrying out routine investigations during outbreaks; two were discovered in slaughter-houses and in four the lesions were atypical. During this period there were two convictions for failure to report suspected cases. One was in

GREAT BRITAIN

Figure I

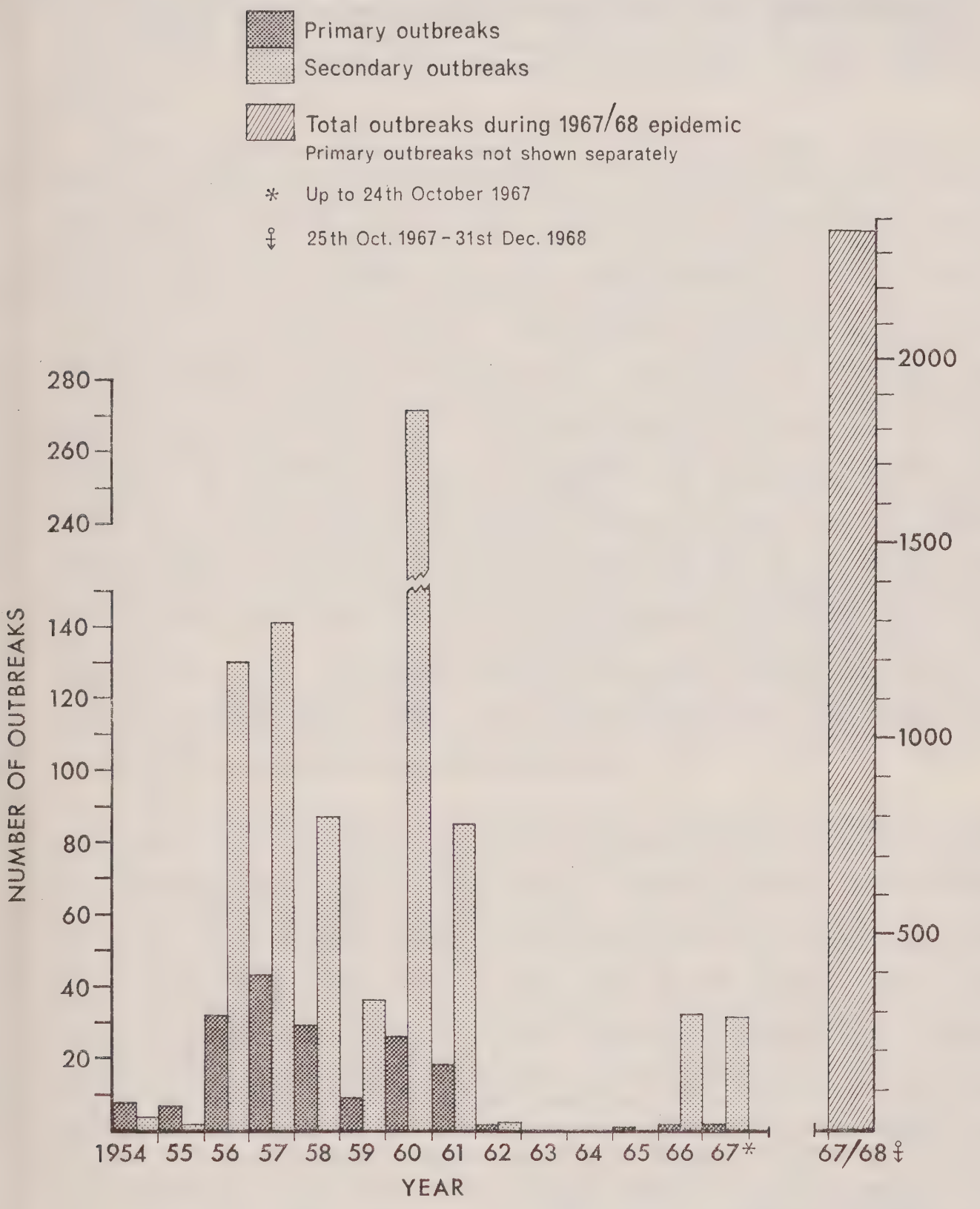
Prevalence of Foot and Mouth Disease Virus Types 1954 – 1967



Source:- Ministry of Agriculture

Figure II

Relationship of Primary Outbreaks of Foot-and-Mouth Disease to Secondary Spread in Great Britain, 1954 to October, 1967



Source: Ministry of Agriculture

Gloucestershire in March, 1960 and the other was in Warwickshire following an outbreak of disease on 4th September, 1967 where the animals were found to have been infected for seven to ten days when the outbreak was confirmed.

63. A recent example of atypical lesions occurred in the initial outbreak in Northumberland in 1966. At the first investigation the clinical diagnosis presented difficulty and the laboratory tests proved negative. Restrictions were removed but these were re-imposed when the disease was confirmed on clinical grounds two days later on the original farm and on two nearby premises.

CHAPTER V

THE 1967/1968 EPIDEMIC

64. In October, 1967 the first outbreak of foot-and-mouth disease in what was to become the worst recorded epidemic in this century, was reported at Bryn Farm, Nantmawr, Oswestry, Shropshire. The epidemic, which lasted until 4th June, 1968, caused 2,364 outbreaks, on 2,346 farms, 18 of which were infected on two occasions. The epidemic resulted in the slaughter of 433,987 animals, including 211,825 cattle, 113,766 pigs, 108,345 sheep and 51 goats.

65. The sequence of events relating to the outbreak on Bryn Farm was as follows. On Saturday, 21st October the owner noticed that one sow was lame; one day later a second sow was seen to be lame. Both animals were removed from the yard and housed. By Wednesday, 25th October a third sow and eleven store pigs were ailing and at this stage veterinary advice was sought. Before the veterinary inspector arrived at the farm, two cows had been sent in the morning to Oswestry market. The inspector diagnosed foot-and-mouth disease immediately on examining the pigs and found that seventeen were infected. (It is probable that the outbreak on this farm had started in the sows that had been seen to be lame on 21st and 22nd October and that they had transmitted the disease to the remaining pigs). As soon as the disease was diagnosed, the usual restrictions were applied to the farm and to the market. There were 1,963 animals still in Oswestry market and these were detained in the sale yard. One of the two cows that had been sent to the market from Bryn Farm had already left the market by vehicle but was stopped by the police and returned to the farm; the other cow was returned to the farm direct from the market. These two animals were included in a veterinary examination of all the stock at Bryn Farm on the morning of Thursday, 26th October by which time it was found that 28 pigs were infected although no cattle showed any clinical signs. The entire stock on the farm, consisting of 71 cattle, 67 pigs and 47 sheep, were slaughtered and buried that day.

66. It was decided that none of the stock that had passed through, or were detained in, Oswestry market should be slaughtered as the two cows which had been sent there from Bryn Farm had not shown any signs of being infected with foot-and-mouth disease. The decision was therefore taken to clear the market of the detained animals which were inspected and licensed to move either to slaughter-houses or to various farms in the Infected Area. This decision caused much concern among farmers since it was feared that as a result of this dispersal the disease would spread. Nevertheless the market was cleared by the morning of Saturday, 28th October. Many of the animals that had been sent to the market on the Wednesday had been dispersed before movement restrictions were applied, and some had gone as far afield as Banffshire and Devon. These were traced and examined by the veterinary staff of theMinistry of Agriculture. The animals that had been detained and subsequently dispersed were also later re-examined by veterinary inspectors. None of the animals that had been in the market developed foot-and-mouth disease as a result of contact with the animals from Bryn Farm.

67. A second outbreak of the disease occurred on Saturday, 28th October and a third was confirmed on the next day; both were in close proximity to Bryn Farm. The situation at this stage did not give cause for anxiety to the Ministry of Agriculture.

68. The position changed dramatically on Monday, 30th October. Nine outbreaks were confirmed on that day and although six of them were close to the original outbreak, one was at Ruabon, Denbighshire twelve miles distant, another at Darnhall, in Cheshire 35 miles away and another at Carnforth in Lancashire nearly 100 miles away. On Tuesday, 31st October eleven more outbreaks were reported in Cheshire and Shropshire. This concluded the first seven days of the epidemic during which there had been 23 outbreaks.

69. In the next seven days beginning 1st November there were 104 outbreaks, in the following seven days 222, and from then on there was a steady increase in the number of outbreaks until the peak was reached towards the end of November when 490 occurred within the seven days beginning 22nd November. Thereafter there was a steady, but slow, decline in the number of outbreaks until towards the end of February, 1968. From then on there were relatively few outbreaks but they continued through March, April and May until 4th June, 1968 when the last outbreak occurred.

70. During the later phase of the epidemic, from mid-February onwards, eighteen outbreaks occurred on previously infected farms which had been allowed to restock. Of these, seventeen were on farms situated in heavily infected areas of the north-west Midlands. After investigating the eighteen outbreaks the Ministry of Agriculture considered that twelve of them were due to a recrudescence of the disease, possibly as a result of infected material remaining on the farm after the original outbreak, and that the remaining six were due to spread of infection from neighbouring farms. The recrudescent outbreaks occurred in Cheshire (4), Staffordshire (2), Shropshire (2), Flintshire (2), Denbighshire (1) and Worcestershire (1).

71. The general pattern of the epidemic is illustrated in Figure III and Map II which show that the north-west Midlands and North Wales were the most heavily infected areas.

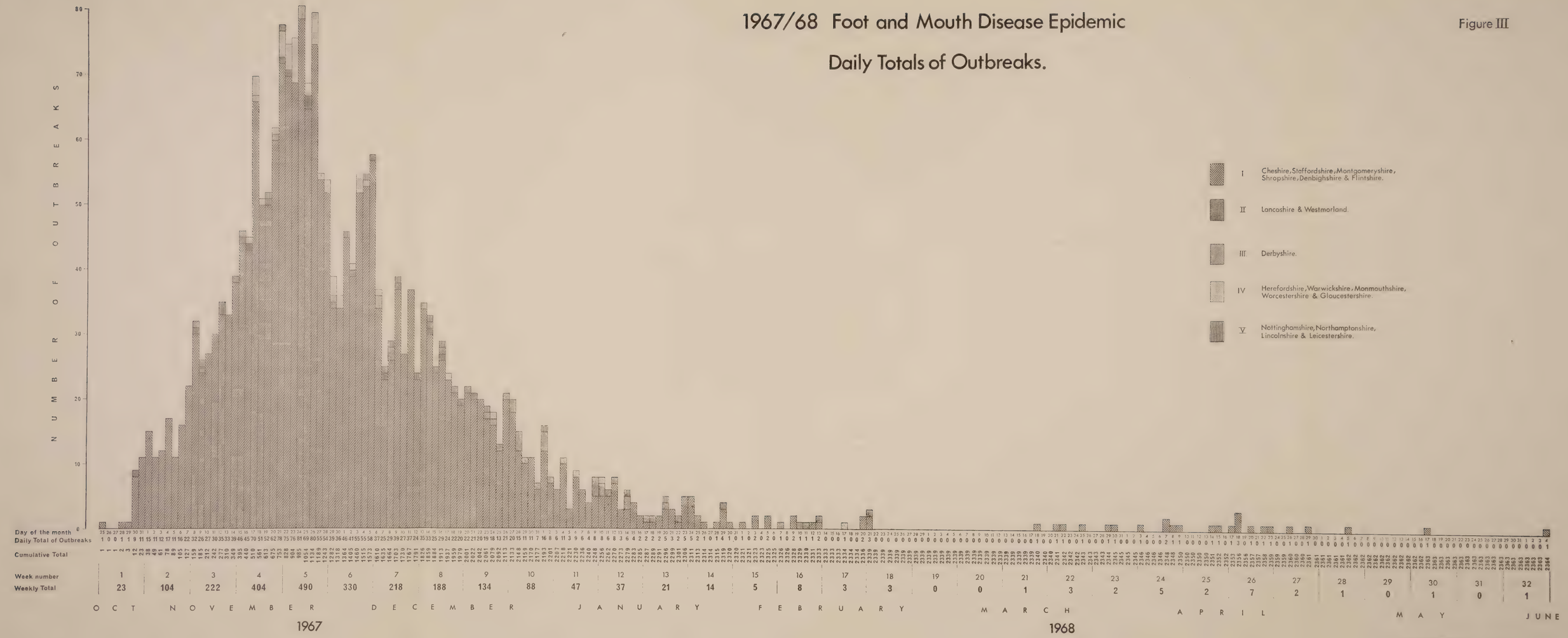
(*a*) Origin

72. The Report of the Ministry of Agriculture's Chief Veterinary Officer on the origin of the 1967/1968 foot-and-mouth disease epidemic (Cmnd. 3560) was submitted to us as evidence. Its text is reproduced in Appendix III. The Chief Veterinary Officer reported that the initial outbreak of the disease was in pigs at Bryn Farm on 25th October, 1967. He considered all the known possible means by which foot-and-mouth disease virus could have been brought to the farm and he dismissed the possibility of any connection between the outbreak at Bryn Farm and the last previous outbreak in Warwickshire in September, 1967. The Chief Veterinary Officer concluded that the most likely source of infection was frozen Argentine lamb which might have been supplied to the farm during October. A consignment of 770 frozen lamb carcases from Establishment 1408 in Argentina had been widely distributed in Cheshire and Shropshire between August and November, following importation on 25th August. The Chief Veterinary Officer drew attention to the large number of outbreaks which were reported almost simultaneously over a wide area; he

1967/68 Foot and Mouth Disease Epidemic

Daily Totals of Outbreaks.

Figure III



Source: Ministry of Agriculture

Map II

Distribution of outbreaks of Foot and Mouth Disease – the 1967/68 Epidemic in Great Britain

Note: The numbers show outbreaks in the areas outlined

Source:- Ministry of Agriculture

suggested that there might have been a number of primary outbreaks at about the same time and that there was a possible link with the imported frozen lamb carcases.

73. The Report referred to other consignments of lamb from Establishment 1408 which had been traced to Nottinghamshire, the west Midlands, London, the area around Portsmouth and Southampton, Bristol and South Wales and Newcastle where no outbreaks occurred. It also pointed out that later on in the epidemic new isolated foci of disease arose in widely dispersed locations. Some of the farms involved could be linked with frozen lamb from Establishment 1408 but there was no clear evidence that the lamb was responsible for any of these outbreaks. Samples for virus isolation were not taken from lamb carcases from Establishment 1408 as the consignment had already been distributed, but samples were taken from other lamb carcases from Argentina and no virus was isolated. The Chief Veterinary Officer's summing up was that he had been unable to discover any possible source of the infection except frozen Argentine lamb which, he concluded, was the cause of the initial outbreak on Bryn Farm and some of the subsequent outbreaks (see Appendix III).

74. The Chief Veterinary Officer's Report was written on 7th February, 1968, before a full investigation of all the outbreaks had been completed. The Ministry of Agriculture gave evidence based on their subsequent findings which they claimed did not detract from those of the Report in any way but rather served to support them. Their full investigation showed that in 24 outbreaks throughout the entire epidemic there was a possible link with lamb from Establishment 1408 but that in a number of these the only evidence was that the lamb had been distributed in the district. In addition sixteen other outbreaks had tenuous links with meat of South American origin—some of which could possibly have come from Establishment 1408.

75. Map III shows the primary distribution of lamb from Establishment 1408 in Great Britain during the period July to December, 1967. We were told that a substantial quantity was redistributed in the rural area north and north-west of Oswestry. Map IV shows the location of retailers in the north-west Midlands receiving Argentine frozen lamb in the months August to November, 1967, both from Establishment 1408 and other establishments, and also the extent of the epidemic up to the end of November. It was clear to the Committee that the lamb had been distributed through normal commercial channels and no blame can be attached to any of the distributors.

76. The general pattern of bulk distribution of South American meat in Great Britain in the period July to December, 1967 was also investigated by the Ministry of Agriculture. Beef, and to some extent offal, were widely distributed in Great Britain though very small amounts went to Scotland, the south-west of England and East Anglia. Lamb and mutton were distributed to the major cities and considerable quantities were sent to centres within or bordering on the main areas of infection. However, from Dover to Bournemouth and north to Salisbury and London, over a thousand butchers' shops were receiving Argentine beef, mutton, lamb and offal during that period and no outbreaks occurred in these areas of England.

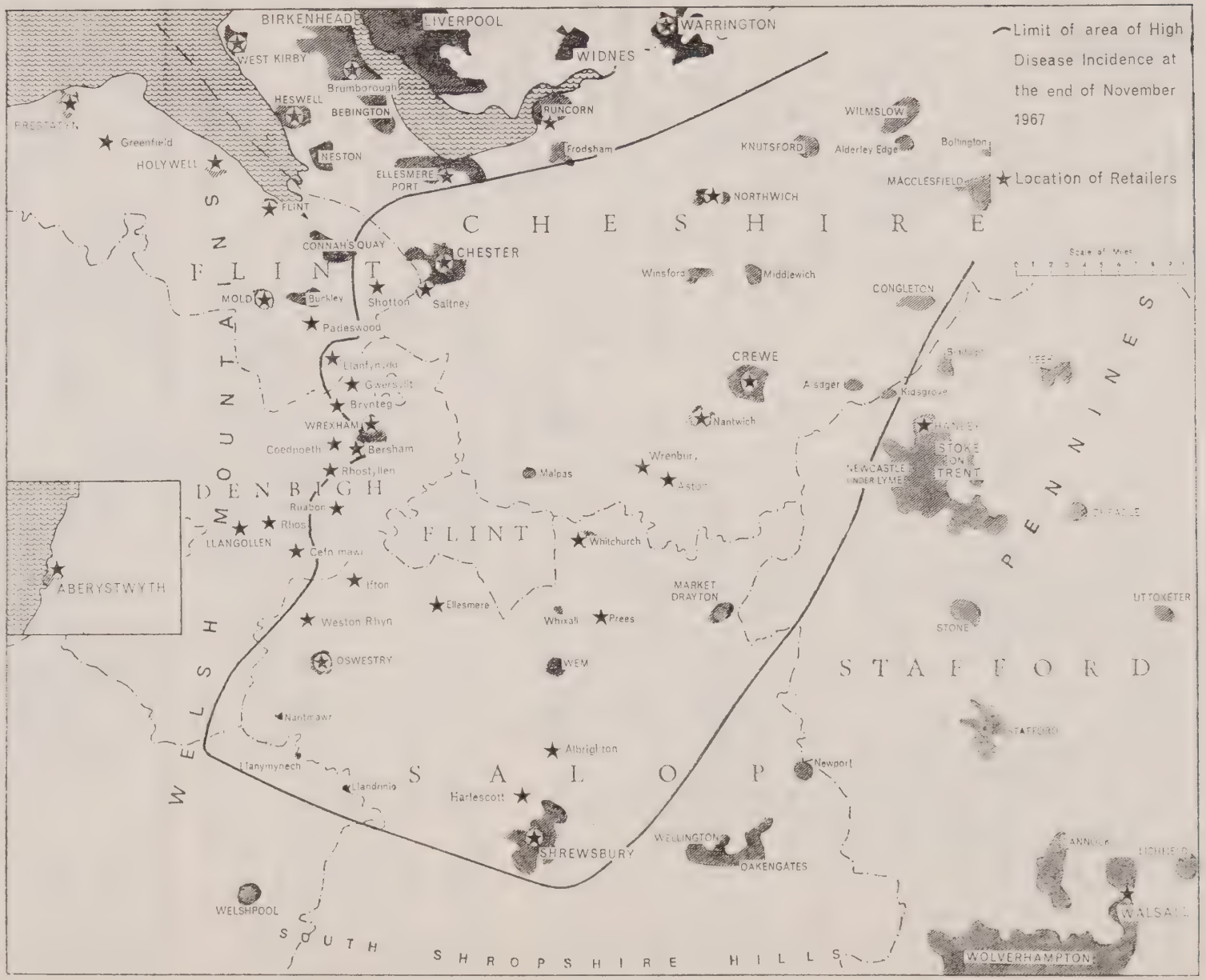
77. In view of the large number of outbreaks of the disease which rapidly occurred in the early period of the epidemic, for example 61 in the first ten days, the question was put to many of our expert witnesses as to whether they

Primary distribution of lamb from Establishment 1408 in Argentina for the period July to December 1967

Source:- Ministry of Agriculture

Map IV

Location of Retailers in the North West Midlands who received Argentine lamb in August to November 1967



Source:- Ministry of Agriculture

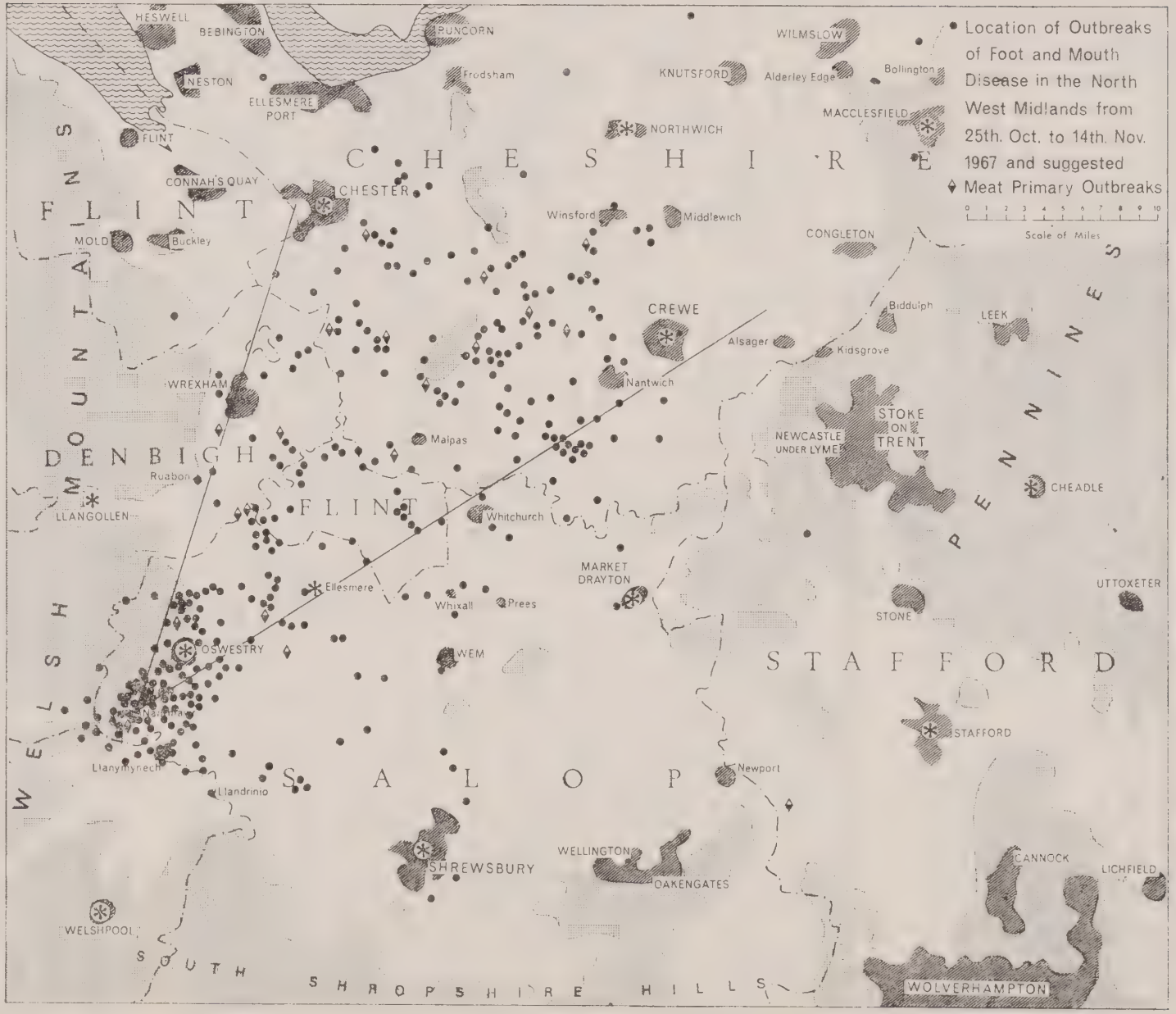
considered the epidemic was a result of one primary outbreak or a number of primary outbreaks occurring almost simultaneously. Experts from the Ministry of Agriculture considered that the weight of infection at Bryn Farm was hardly sufficient to account for the explosion of outbreaks that followed and pointed out that the two cows that had been sent from the farm to Oswestry market had shown no clinical signs of the disease, nor had they transmitted infection to other cattle in the market. The Ministry's witnesses were inclined to the opinion that there had been a series of multiple primary outbreaks over a short period and that the one at Bryn Farm happened to be the first to become apparent. They supplied Map V on which are plotted the outbreaks in the Cheshire Plain during the period 25th October to 14th November, 1967 and on which are indicated 19 outbreaks that might have been primaries resulting from imported meat. The basis for some of these suggested primary outbreaks was no stronger than that imported frozen lamb, including some from Establishment 1408, had been distributed in the district.

78. The question of whether the characteristics of the strain of foot-and-mouth disease virus isolated from the initial outbreak would throw any light on the origin of the epidemic was put to the Animal Virus Research Institute. They informed us that the strain isolated from this outbreak belonged to sub-type 0_1 as did other strains isolated throughout the epidemic. One of these, isolated from an outbreak at Wrexham on 1st November, 1967, was designated British Field Strain (BFS) 1860 and used as the prototype for the epidemic. As sub-type 0_1 is widely distributed throughout Europe, South America and other countries it was impossible to draw any firm conclusions about the origin of the epidemic on the basis of typing only. The Institute thought that it was possible that the virus had been introduced into this country in South American meat but they did not dismiss the possibility that it might have come from Europe. It was pointed out that there was a similarity between the BFS. 1860 strain and the 0_1 Lausanne strain which had been common in Europe. The experts could not explain how the virus might have been introduced into this country from Europe but they reminded us that travellers could have carried the virus, although this was a remote possibility. In addition they drew our attention to the Warwickshire outbreak in September, 1967 and told us that the 0_1 strain isolated at that time was indistinguishable in its stability in the laboratory from strain BFS. 1860 of the 1967/1968 epidemic.

79. Early in the outbreak the Animal Virus Research Institute made some tests of antibody levels for foot-and-mouth disease in sera from sheep sent for slaughter from farms around the original area of infection; the results were negative. On all the evidence available the possibility was dismissed that sub-clinical infection in sheep had preceded the initial outbreak at Bryn Farm. In January, 1968, after the peak of infection had passed, further tests were made in an attempt to detect whether there had been any inapparent infection among sheep on farms contiguous to those where foot-and-mouth disease had occurred. Samples of sera from 59 sheep on 23 farms in the Oswestry area were tested. In the opinion of the Institute the antibody levels to foot-and-mouth disease virus were sufficiently high in three of the serum samples, taken from two farms, to indicate that infection had occurred; these sheep, however, had not passed the infection on to the rest of the flock. The possibility of infection being present

Suggested Meat Primary Outbreaks in relation to
Outbreaks of Foot-and-Mouth Disease in the environs of the Cheshire Plain 1967/8

Map V



Source: Ministry of Agriculture

and of being a danger to other stock was regarded as negligible so no further action was taken by the Ministry of Agriculture. We questioned our witnesses on the significance of these observations with particular care. The Animal Virus Research Institute and the Ministry of Agriculture assured us that these incidents were exceptional and did not contribute to the spread of infection during the epidemic. Members of the Ministry's staff agreed that the results of the serological tests might well have been caused by foot-and-mouth disease virus. However, they were of the opinion that the animals had not had clinical foot-and-mouth disease, that they had not passed infection to contacts on the same farm and that they would not spread the disease to other susceptible animals.

80. We conclude that it is impossible to establish without doubt the origin of the 1967/1968 epidemic. However, having considered all the facts we think that there is a basis for a reasonable inference that the most probable source of the epidemic was infected meat from South America. We do not have sufficient evidence to suggest that the infected meat came from any one particular meat exporting country in South America or from any one particular establishment.

81. We cannot completely set aside other likely sources of the epidemic, having regard to the multiplicity of means by which the disease can be transmitted. We consider for instance that the epidemic may have had a link with the Warwickshire outbreak of September, 1967 which was also attributed by the Ministry of Agriculture to South American meat. One theory that can be dismissed is that the epidemic might have been started by windborne virus from the Continent. The Meteorological Office studied the meteorological pattern and were unable to find any suitable wind track during the critical period.

82. We also conclude that it is impossible to identify the number of primary outbreaks in the epidemic. It is difficult however, to explain the rapid development and extension of the epidemic other than by accepting that a number of foci were established more or less simultaneously. Although such foci may have been primary outbreaks, arising from the distribution of imported meat, there is nevertheless the possibility that some of them may have been secondary outbreaks. For example some of the 28 pigs on Bryn Farm, affected at the time of slaughter, could have been excreting virus for ten days, and two of them for fifteen days, before being slaughtered. However, if this had been so it is surprising that none of the cows on Bryn Farm developed foot-and-mouth disease, and the two sent to market were unlikely to have been in the incubating stage because they did not affect the other animals in the market. Another example of the possibility that a number of foci may have been established early in the epidemic as a result of secondary spread was an outbreak confirmed in Oswestry rural parish on 30th October when seven dairy cows in a herd of 128 were found to have clinical signs of the disease; one of the cows was considered to have lesions that were three days old. Seven other cattle showed clinical signs and all the infected animals together with the animals in immediate contact, had been slaughtered by 31st October. The remaining 77 animals in the dairy herd were slaughtered on 1st November and twelve sheep were slaughtered on 2nd November. Such a situation could be conducive to the

dissemination of the virus and the initiation of further multiple outbreaks, thereby contributing to the rapid development of the epidemic in its early phase. Another cause of multiple outbreaks could have been the result of disease being present for some time in animals which did not show clinical signs but which were excreting virus; we considered this but found no evidence to support the theory. Neither was there any evidence that the disease had been deliberately concealed.

(*b*) Spread

83. Table IV shows the weekly record of outbreaks divided, for convenience, into five areas. These are:

Area I—NORTH-WEST MIDLANDS AND NORTH WALES	Cheshire, Denbighshire, Flintshire, Montgomeryshire, Shropshire and Staffordshire.
II—LANCASHIRE & WESTMORLAND	
III—DERBYSHIRE	
IV—SOUTH-WEST MIDLANDS AND SOUTH WALES	Gloucestershire, Herefordshire, Monmouthshire, Warwickshire and Worcestershire.
V—EAST MIDLANDS	Leicestershire, Lincolnshire, Northamptonshire and Nottinghamshire.

This table, together with the map of distribution of outbreaks (Map II) and the chart of daily totals (Figure III), all show that by far the largest number of outbreaks (94 per cent) occurred in the north-west Midlands and North Wales (Area I), and we have concentrated out discussion in the following paragraphs mainly on the development of the disease in that area. We have however included some comment on outbreaks in other areas where these appeared to have some epidemiological significance. The Ministry of Agriculture attributed nearly all the secondary outbreaks to local spread which might have been brought about by wind, birds, rodents, other fauna and unknown means. They attributed 51 other outbreaks to the causes shown in Table V.

TABLE IV

***Returns of Outbreaks of Foot-and-Mouth Disease throughout the 1967/1968 Epidemic**

Period beginning	Area I North-West Midlands and North Wales	Area II Lancashire and Westmorland	Area III Derbyshire	Area IV South-West Midlands and South Wales	Area V East Midlands	Total for period
1967 October 25th	22	1	—	—	—	23
November 1st	104	—	—	—	—	104
November 8th	215	5	2	—	—	222
November 15th	385	4	3	10	2	404
November 22nd	464	3	—	23	—	490
November 29th	314	3	1	10	2	330
December 6th	207	2	5	1	3	218
December 13th	177	3	5	1	2	188
December 20th	126	1	5	1	1	134
December 27th	76	—	11	—	1	88
1968 January 3rd	42	—	4	1	—	47
January 10th	29	—	6	1	1	37
January 17th	16	—	4	—	1	21
January 24th	13	—	1	—	—	14
January 31st	5	—	—	—	—	5
February 7th	4 (1)	—	4	—	—	8
February 14th	2	—	—	1 (1)	—	3
February 21st	2 (1)	—	1	—	—	3
February 28th	6 (4)	—	—	—	—	6
April 1st	16 (4)	—	—	—	—	16
May 1st	2 (1)	—	—	—	—	2
June 1st	1	—	—	—	—	1
Grand Total	2,228 (11)	22	52	49 (1)	13	2,364

* Returns from 25th October, 1967 to 28th February, 1968 are for seven-day periods and thereafter monthly.

Note: The numbers in brackets indicate the recrudescent outbreaks which are included in the totals.

Source:- Ministry of Agriculture

TABLE V

Analysis by the Ministry of Agriculture of Sources of Infection in Outbreaks of Foot-and-Mouth Disease during the 1967/1968 Epidemic

Attributed to Movement of—	
Animals	1
Vehicles	18 (*a*)
Veterinary Surgeons	6
Other persons	4
Milk products	9 (*b*)
Hay	1
Recrudescent outbreaks.. ..	12
Total	51

(*a*)—15 milk lorries (8 milk tankers, 7 churn collections), 2 stock lorries, 1 slurry tank.

(*b*)—8 skim milk, 1 churn washings.

84. The Ministry of Agriculture's witnesses thought that compared with previous outbreaks of foot-and-mouth disease in recent years, the 1967/1968 epidemic showed some new features in that the speed and extent of spread were abnormal. There was, however, no evidence from the length of the incubation period of the disease that the infection differed from previous ones. In cattle the period of incubation was from two to five days, in pigs from five to eight days and in sheep (although this was more difficult to determine precisely) from three to seven days. There was evidence that some sheep had exhibited a greater resistance to infection than was expected but such resistance had occurred in outbreaks in the past, and even when severe infections did occur in sheep they did not give rise to much local spread of the disease. Another characteristic of the epidemic was that pigs did not seem to be readily infected; of the 113,766 pigs slaughtered only 327 showed clinical signs of disease.

85. Laboratory evidence obtained by the Animal Virus Research Institute showed that the 0_1 sub-type strain of virus (BFS. 1860) isolated from the 1967/1968 epidemic had characteristics similar to those of other sub-type 0_1 strains isolated in previous outbreaks in Great Britain. It has been established that the BFS. 1860 strain is a little more stable under laboratory conditions than other similar strains but it was considered that this factor did not contribute significantly to the nature of the epidemic.

86. During the whole period of the epidemic samples were taken from animals where a primary outbreak was suspected, from a random number of cases in the heavily infected areas, and from clinically doubtful cases for diagnostic purposes. The samples were examined at the Animal Virus Research Institute for isolation of virus and typing, and all strains recovered belonged to sub-type 0_1. The results are shown in Table VI. A more detailed investigation

TABLE VI

Isolation of Foot-and-Mouth Disease Virus from Samples taken during the 1967/1968 Epidemic

Source	Number of samples examined	Number of samples from which the virus was isolated
Confirmed cases ..	117	114
Doubtful cases ..	105	19
Total	222	133

was also made of five samples from animals in the areas of Oswestry, Lincolnshire, Nottinghamshire, Warwickshire and Leicestershire between 28th October, 1967 and 19th January, 1968. All the strains of virus isolated from these samples also fell into sub-type O_1 and there was no evidence of any change in sub-type during the course of the epidemic.

87. Experiments were also made at the Animal Virus Research Institute to relate the time of the excretion of the virus by infected animals to the development of lesions. Cattle, sheep and pigs were infected by contact with other animals which had been infected by injecting the virus, and samples for isolation of the virus were taken from various sites during the development of the disease. The results of this work are summarised in Table VII.

TABLE VII

Isolation of Foot-and-Mouth Disease Virus in Relation to Development of Lesions

Animals	Number of days for lesions to develop after exposure to infection	Number of days before development of lesions when virus was first isolated	
		Maximum	Mean
Steers	5– 8	5	2·5
Cows	6– 8	5	2·7
Sheep	8–11	5	2·5
Pigs	7–13	10	5·0

88. In the same experiments determinations were made of the quantity of virus isolated from these sites. The results are shown in Table VIII.

TABLE VIII

Quantity of Foot-and-Mouth Disease Virus Isolated at Various Sites in Animals

Site	Maximum number of infectious particles per sample or per ml. of milk*		
	Cattle	Sheep	Pigs
Pharynx	$10^{5.5}$	$>10^{3.5}$	$>10^{3.3}$
Milk	$10^{5.2}$	—	—
Rectum	$10^{1.8}$	$10^{1.0}$	$10^{2.6}$
Vagina	$>10^{3.3}$	$>10^{3.1}$	$10^{3.0}$

* Number of infectious particles indicated by log scale.
Thus $10^2=100$, $10^5=100{,}000$ and so on.

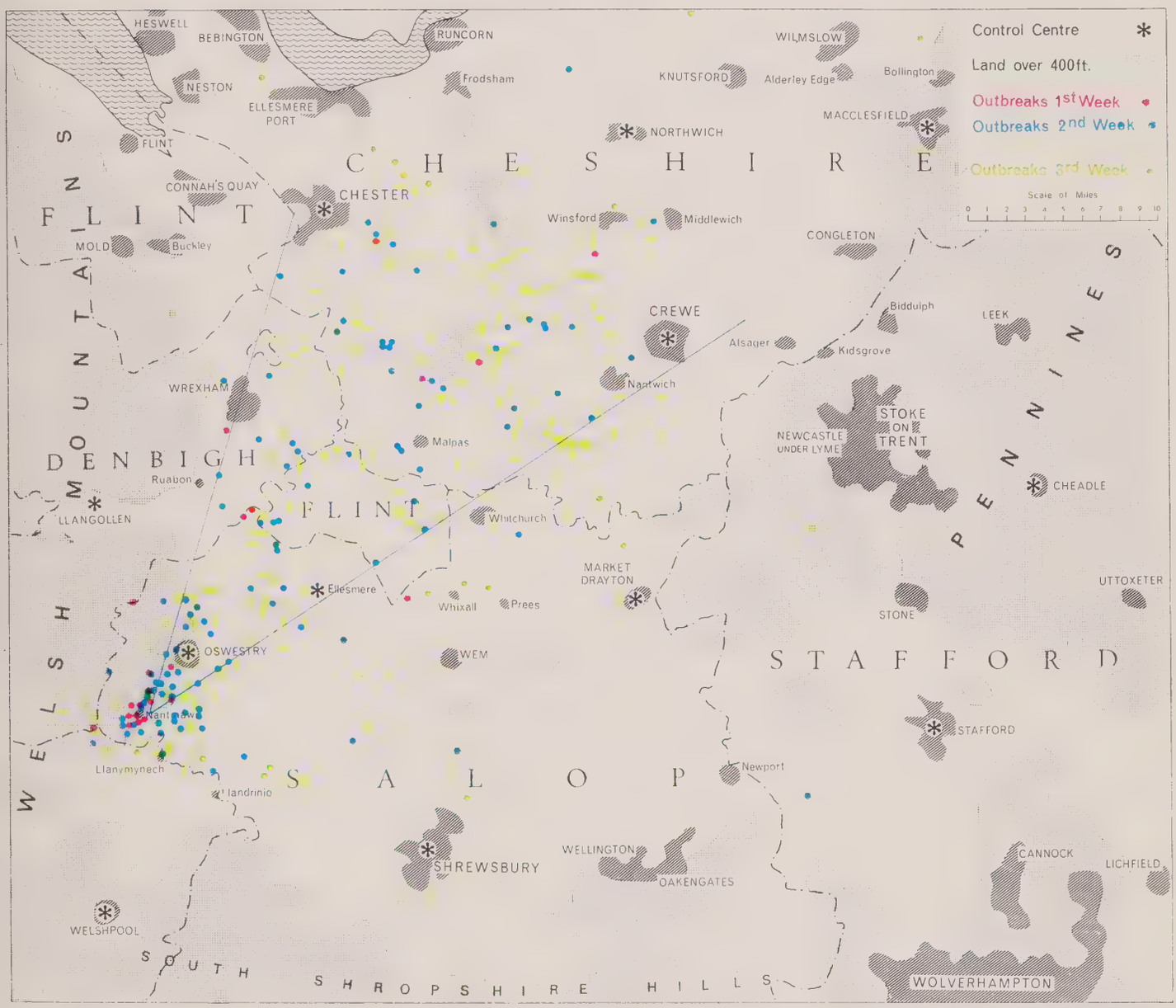
89. It is clear from the results in paragraphs 87 and 88 that considerable quantities of foot-and-mouth disease virus could have been excreted from infected cattle and sheep for as long as five days, and in the case of pigs for as long as ten days, before the appearance of clinical signs. We think, however, that this is not necessarily a unique characteristic of the BFS. 1860 strain because little work has yet been done on strains isolated from previous outbreaks.

90. By the second week of the epidemic, when the disease was becoming widespread, the pattern of spread seemed to be conforming to a well-defined shape. This took the form of a fan from an apex in the hills at Nantmawr with the western boundary running northwards alongside the mountains towards Wrexham and Chester and the eastern boundary running towards Whitchurch and Crewe. The Cheshire Plain lay within these boundaries. In the third and fourth weeks of the epidemic there was roughly a twofold increase in the number of outbreaks all but 24 of which were in the Cheshire Plain or the immediate surroundings. Map VI illustrates the developing pattern of spread of the disease in the Cheshire Plain during the first three weeks of the epidemic. This area has always had a high concentration of livestock and part of it is the most heavily stocked dairy country in the world. In the conditions of the outbreaks, concentration of livestock in the Cheshire Plain undoubtedly favoured the rapid spread of the disease. The maps at Appendix IV show how cattle densities in Great Britain have increased over the last nine years and how closely the areas of highest density are related to the areas which suffered the highest concentration of outbreaks.

91. There is a continuing tendency in Great Britain for livestock to be kept in large groups; stocking densities are becoming heavier and there is much more communication of all sorts between farms, including the movement of animals. The British Veterinary Association and the Royal College of Veterinary Surgeons thought that in some areas all the livestock should be regarded as an integrated population in relation to the spread of disease. This is particularly

Illustration of the Developing Pattern of Spread of Foot-and-Mouth Disease in the Cheshire Plain during the First Three Weeks of the 1967/1968 Epidemic

Outbreaks of Foot and Mouth Disease in the environs of the Cheshire Plain 1967/8 Map VI



Source: Ministry of Agriculture

true in dairying areas with a high percentage of small farms and with few natural breaks such as arable land and woodland between them. In this respect it is interesting to note that in the less densely stocked areas such as Nottinghamshire, Lincolnshire and Northamptonshire there was little or no local spread of the disease. Developments in husbandry, and in the industries supporting agriculture such as those mentioned above, are by no means the only ones which might play a part in the spread of the disease. Other modern practices in relation to livestock, milk marketing, artificial insemination, and transport and deliveries to farms contribute to the risks (see also paragraph 40).

92. The Meteorological Office studied the meteorological factors that might have had a bearing on the pattern of spread of the epidemic and they concluded that wind could have played an important part in spreading infection. They thought it was significant that at the time of the initial outbreak at Nantmawr and for the following nineteen days the prevailing wind was from the south-west and that about 75 per cent of the first 100 outbreaks were lying to the north and north-east of the initial outbreak. They also thought it was significant that rain fell on seventeen of the nineteen days when winds blew consistently from the south-west. We noted that very few outbreaks occurred in the opposite direction, into the wind (see Map VI). This cannot be accounted for over a ten mile range either by a difference in concentration of holdings or of concentrations of livestock. The evidence supports the theory that wind carriage of the virus together with deposition by rain at night may have been responsible for secondary outbreaks particularly during the first month of the epidemic. The range of spread might have been up to thirty miles depending on weather conditions but the longer jumps of infection into Lancashire, Nottinghamshire and Warwickshire were not thought by the Meteorological Office to be associated with windborne spread.

93. The Ministry of Agriculture investigated the possibility that the virus might sometimes have been carried by thermal air currents from sites where infected carcases were burnt. There were three instances in Derbyshire during December, 1967 where outbreaks occurred downwind of infected premises after an interval of from eight to eleven days. In these three outbreaks the carcases had been destroyed by burning, and cremation could have been responsible for the spread of disease. In other outbreaks in Derbyshire where conditions appeared to favour the spread of disease while carcases were burning, there were no subsequent related outbreaks.

94. Another series of outbreaks which occurred during the fourth week of the epidemic was of significance in relation to the spread of disease. At Spetchley in Worcestershire, some forty miles from the nearest outbreak in the north-west Midlands, three outbreaks occurred in pigs, and were then followed by a further 27 outbreaks, all within a radius of three miles. The three original outbreaks were attributed by the Ministry of Agriculture to the feeding of the pigs with skim milk from a dairy where the plant had probably been contaminated by infected milk. In the same week outbreaks occurred in Gloucestershire, at Winchcombe and near Moreton-in-the-Marsh; in both instances pigs were the first animals affected. The source of infection was held to be skim milk from the dairy that had been involved in the Spetchley outbreaks. There was also an outbreak at Wolverhampton which was attributed to skim milk from the same dairy.

95. Although it is generally accepted that infected milk can contaminate persons, containers and vehicles and thus convey the disease to other premises, we were told by the Ministry of Agriculture that it was extremely difficult to assess how much disease had been transmitted in this way during the 1967/1968 epidemic. However, investigations were carried out, in the period from November, 1967 to January, 1968, by the Animal Virus Research Institute, in collaboration with the Central Veterinary Laboratory into the amount of foot-and-mouth disease virus present in milk sampled from various sources in Infected Areas. Their findings are given in Table IX and indicate that some samples of milk contained high concentrations of the virus.

TABLE IX

Quantity of Foot-and-Mouth Disease Virus in Milk from Various Sources in Infected Areas

Source	Number of samples tested	Number of samples positive	Number of infectious particles per ml.* (Average or range)
Bulk tankers	3	2	$10^{2.5}$ to $10^{4.0}$
Churns	42	18	Trace to $10^{5.5}$
Bottles	1	1	$10^{5.0}$
Farm storage tanks ..	1	1	$10^{4.5}$
Cows	3	3	Trace to $10^{2.5}$
Bulk storage tanks ..	2	0	—

* Number of infectious particles indicated by log scale.
Thus $10^2=100$, $10^5=100{,}000$ and so on.

96. There are two risks associated with the bulk collection of milk as distinct from churn collection at the farm gate; the visits from farm to farm by the bulk milk tankers and the possibility of releasing contaminated air from the tankers. The latter risk during transportation is now considered not to be as great a danger as was at first thought but precautions were taken to minimise the danger from this source and in December, 1967 suitable filters were fitted to the air exhausts on bulk milk tankers. The risk from bulk milk tanker collection was, in the case of this epidemic, assessed as only marginally greater than the risk associated with churn collection.

(*c*) Costs

97. The 1967/1968 epidemic was the most serious experienced in Great Britain within this century. The numbers of stock slaughtered during the period October 25th, 1967 to June 4th, 1968 were 211,825 cattle, 108,345 sheep, 113,766 pigs and 51 goats. The agricultural industry was gravely affected and the consequential disturbance and loss to many other interests were substantial. Industries relying on agriculture for their raw materials or for their sales were affected by the controls governing movements in and out of Infected and Controlled Areas, and sporting, leisure and other social activities were upset. Among the sports most seriously affected were horse racing, fishing, hunting,

football, car rallying, cross-country running, camping, canoeing, gliding, and mountaineering. Some of those whose livings were associated with these activities suffered considerable financial loss.

98. It is impossible to put forward a reasoned estimate of the total cost of the epidemic to the community as a whole. This would mean attempting some assessment of the losses caused to many organisations and persons outside the agricultural industry; it would also mean attempting to put some value on the inconvenience and mental strain caused to many individuals both in agriculture and generally, not only by the necessity of slaughtering a vast number of animals but also by living and working under the unpleasant and restrictive conditions which were imposed during the epidemic. We feel, therefore, that it is reasonable to attempt to assess only the cost relating to the agricultural sector of the economy, to industries and services ancillary to agriculture, to the public sector and to consumers. These costs can usefully be divided into direct costs and indirect costs.

99. The direct cost of the 1967/1968 epidemic is estimated at £35·1 million largely made up of costs borne by the Ministry of Agriculture. The main item in this total is the cost of compensation which is provisionally estimated at £26·66 million. Another large item consists of payments for valuing, slaughtering and burying or cremating animals, and for disinfection; these amounted to some £4·2 million. Another major item is the additional staff costs incurred by the Ministry of Agriculture which amounted to some £2·8 million. Other direct costs are included in the total, such as special ploughing grant payments and the £ for £ extra compensation scheme.

100. The indirect costs might be divided into two groups. The first group would cover the loss of income arising from the slaughter of diseased animals and animals that had been in contact with them, for though the farmer is fully compensated for the slaughter of his stock he is still involved in losses. Compensation represents the capital value of the farmer's slaughtered herd which enables him in due time to replace his stock—assuming there has been no upward movement in prices. The operation of the various control measures, however, normally introduces a delay between the time of slaughter and of replacing stock, and because of this and other factors the farmer loses income for which no cash compensation is made. The next group would include costs arising from the general disruption of agricultural production, marketing, and distribution following the imposition of control measures. For long periods during the 1967/1968 epidemic movements of stock were substantially restricted. In particular, the normal pattern of store stock production and marketing was seriously disrupted; from 24th November, 1967 to 31st January, 1968 for example, the whole of Great Britain was a Controlled Area and livestock markets were closed throughout the country.

101. Some of the indirect costs could be quantified if basic assumptions were adopted, but there is scope for a wide divergence of views in relation to these. Different sets of assumptions would result in considerable differences in the calculations and we considered that the limitations were such that it would require extensive research. However, in a prolonged outbreak the indirect

costs are likely to be proportionately greater. Such estimates as we received of direct and indirect costs ranged from £70 million up to £150 million. The estimates in the lower half of this range were the result of extensive studies. A point of some significance is that part of the indirect costs were borne by farmers who did not have the disease on their farms; we received evidence that a substantial number of such farmers had suffered heavy losses. A number of specific cases are discussed in a valuable study* carried out by Professor W. J. Thomas and Mr. J. Stewart, of the Manchester University Department of Agricultural Economics. The authors mention, for example, the case of two farmers who normally fattened store pigs and who lost several weeks' output because they could not purchase such animals. Moreover they also had to keep on fat pigs beyond the optimum marketable weight thus incurring a loss of about £1 per pig. In one case the loss of income over the previous year was £430 and in the other £200. They also mention the case of six dairy farmers (for whom they had financial accounts) who incurred losses estimated to range from £5 per cow (or £4 per acre) to £20 per cow (or £10 per acre) because of the delay in getting cows and heifers into calf, because they could not get rid of cows which they would normally have culled, or because they incurred additional expenses on fodder to keep their animals indoors. None of these farmers qualified for compensation payments.

* " Farmers and Foot-and-Mouth Disease " District Bank Review, December, 1968.

CHAPTER VI

PREVENTION AND CONTROL OF FOOT-AND-MOUTH DISEASE

(a) Outside Great Britain

102. At one time some countries where foot-and-mouth disease was endemic accepted that they would experience recurring outbreaks of the disease, and steps were taken when an outbreak occurred to expedite its spread throughout flocks and herds so that the epidemic would be terminated as soon as possible. This attitude to the disease has disappeared except in the most backward areas. In other countries isolation of the affected animals has been practised but this has usually been unsuccessful because of the highly infectious nature of the disease. These measures are still accepted by nomadic peoples whose husbandry is dictated by climatic conditions. In those tropical countries where wild animals share pasture with other livestock it may be necessary to accept recurring attacks of the disease although in some African countries measures are being taken to separate the wild from the domestic animals by stock-proof fences. In many such areas vaccination is now applied.

103. Control of foot-and-mouth disease as now practised by many countries can be considered under two main headings: first the methods of preventing the introduction of the disease into a country with particular attention to the importation of meat from countries where the disease is endemic: second the methods of controlling the spread of the disease when it is present in a country either in endemic or sporadic form.

Control of imports

104. The best method of reducing the incidence of foot-and-mouth disease is by controlling imports of materials which may be contaminated by the virus. Most countries have legislation to control such imports.

Slaughter policy

105. The slaughter policy is only acceptable to countries or areas of countries where foot-and-mouth disease is not endemic and where introductions of the disease are relatively infrequent. It may be applied alone or in conjunction with a vaccination scheme (see paragraphs 119 and 123). The slaughter policy alone would be applied for example in Australia, Canada, Ireland, New Zealand and the U.S.A.. The success of the policy depends on adequate veterinary resources, the co-operation of farmers in quickly reporting the disease when outbreaks occur, and rigid enforcement of movement restrictions and disinfection. It also depends on eliminating the sources of foot-and-mouth disease virus by rapid slaughter and disposal of carcases, tracing animals that have been in contact with infected animals, and restricting the movement of persons and animals in the area of the outbreak. In most countries there is legislation to provide for these procedures.

106. When foot-and-mouth disease is diagnosed the infected animals are destroyed and the carcases disposed of as quickly as possible. Steps are taken to eliminate the risk of animals that have been in contact with the infected animals spreading the disease. In some countries the carcases of slaughtered animals are disposed of by burying or burning on the farm and in others by removing animals—alive or dead—in specially constructed vehicles to destructor plants. Sometimes the carcases are sterilised and processed for manufacturing purposes, but they may be salvaged for human consumption if they are apparently healthy.

General Vaccination

107. There have been significant advances in the production of foot-and-mouth disease vaccines and their application in the field over the last fifteen years. There are two forms of vaccine: (i) inactivated vaccine and (ii) live attenuated vaccine. Inactivated vaccine is ideal for use in countries where foot-and-mouth disease is endemic. Great improvements have been made in the preparation of potent inactivated vaccines and these are used in most countries which have adopted vaccination policies. In some centres of research, including the Animal Virus Research Institute, much effort has been directed in the past ten years towards developing live attenuated foot-and-mouth disease vaccine. However, the highest standards of safety and potency have not been attained and the application of this type of vaccine is limited to a few areas. Its successful use reduces the frequency and extent of epidemics and it has been used as a preliminary to a more comprehensive scheme of vaccination with inactivated vaccine.

108. Of those countries that have replied to our questionnaire the following incorporate general vaccination in their control programmes:

Argentina	France	Kenya
Belgium	Federal Republic of Germany	Netherlands
Botswana	Italy	Switzerland
Brazil		Uruguay

109. The types and sub-types of foot-and-mouth disease virus that give rise to the disease in a particular area are usually predictable, and countries that practise vaccination use vaccines containing the virus types and sub-types appropriate for their areas. (The vaccines are referred to as monovalent, bivalent, trivalent or polyvalent depending on the number of different virus types they contain.) In Argentina, Brazil, France, the Federal Republic of Germany, the Netherlands, Switzerland and Uruguay cattle are vaccinated with trivalent vaccines which contain sub-types of three main types of virus. The sub-types may be varied from time to time. In 1968 the sub-types in use were;

Argentina	$A_{24} : 0_1 : C_3$
Brazil	$A_{24} : 0_1 : C_3$
France	$A^* : 0_1 : C_1$
Netherlands	$A_{10} : 0_1 : C_1$
Federal Republic of Germany	$A_5 : 0_1 : C_1$
Switzerland	$A_5 : 0_1 : C_1$
Uruguay	$A_5 : 0_1 : C_3$

*At present being classified for sub-type by World Reference Laboratory, Pirbright.

110. Some strains of foot-and-mouth disease virus have a wide antigenic spectrum and when incorporated into vaccines give a broad measure of protection against a number of sub-types. It has also been shown that animals that have been subjected to routine vaccination on a number of occasions will be better protected against a range of sub-types than those that have received vaccine on only one or two occasions. General vaccination may therefore give some protection against a sub-type which is introduced into an area for the first time. This may not always be the case and if a new sub-type has to be incorporated in vaccine which has to be manufactured a minimum period of two months, to allow for carrying out efficacy and safety tests, is usually required before the vaccine is ready for use. However, world monitoring services (see also paragraph 120) should allow sufficient notice to be given of the spread of new sub-types and thus allow their early incorporation in the vaccine. In an emergency, for example in the face of a rapidly spreading epidemic, vaccines that had passed the safety tests could be used without waiting for the results of efficacy tests and so reduce the waiting period considerably. The same procedure could apply if a new virus type had to be incorporated in the vaccine.

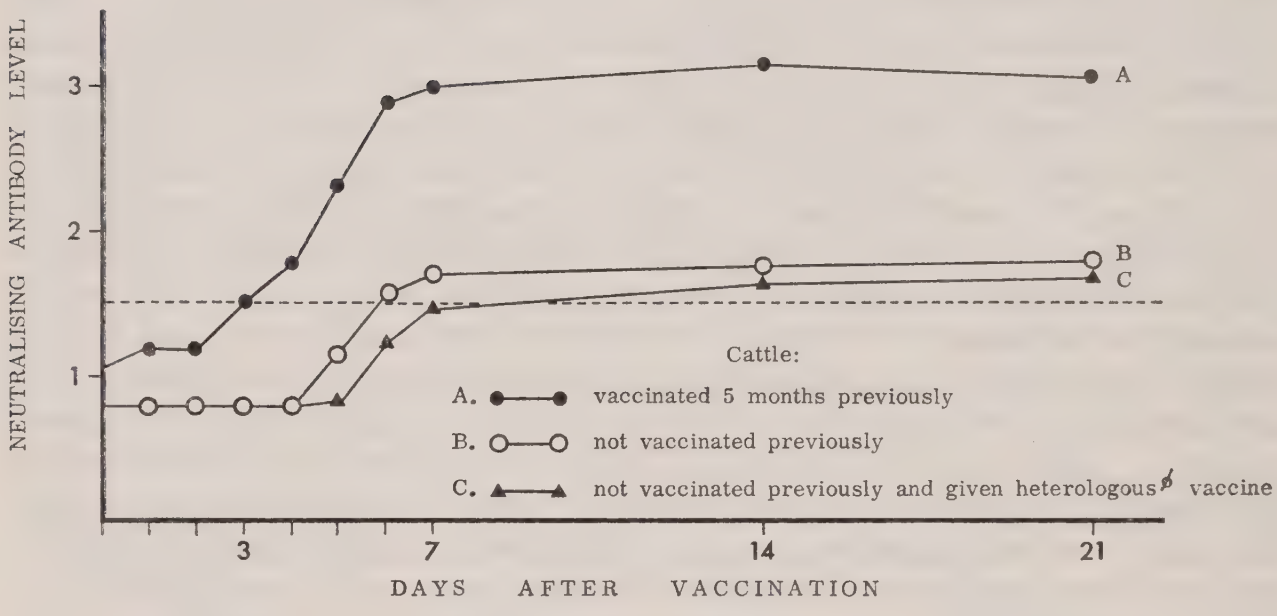
111. The results of experiments at the Animal Virus Research Institute given in the Figure IV overleaf show the antibody production (which is related to protection) in cattle following a single injection of vaccine in which aluminium hydroxide is used as an adjuvant. In animals not previously vaccinated (line B) antibody is produced by the fourth or the fifth day, and by the sixth day is sufficient to resist an average challenge of foot-and-mouth disease virus. It is considered that by the seventh day, 85 per cent of vaccinated cattle would have achieved a sufficient level of antibody (1·5 on the scale used) to be immune to the disease. In cattle that had been vaccinated previously there is a greater and more rapid antibody response (line A). Antibody to a particular sub-type of virus is also produced even when the sub-type used in the vaccine originates from a different strain (line C), but the response is not so rapid and it does not reach as high a level. In all three immunisation prodecures (A, B and C) after about a month there is a gradual fall in antibody level and by the fifth or sixth month it may be undetectable. A similar response to foot-and-mouth disease vaccine occurs in sheep but in pigs it is much less satisfactory.

112. Work on oil adjuvant foot-and-mouth disease vaccines has shown promise and has already reached the stage of field trials. These vaccines are likely to give a reasonable degree of protection within three or four days of vaccination, to prolong the period of immunity and to be almost as effective in pigs as in cattle. Oil adjuvant vaccines that are available at present may produce a tissue reaction around the site of the injection, particularly in pigs, but there is reasonable promise that this drawback will be overcome.

113. Primary outbreaks often occur in pigs and thus theoretically there is an excellent case for vaccinating them. But because of the rapid turnover of the pig population and because hitherto there has been no really satisfactory vaccine for pigs, general vaccination of this species is not usually practised. It is known that in countries with a vaccinated cattle population the disease sometimes remains undetected in pigs for a period and is only revealed when young unvaccinated susceptible cattle are exposed to infection. These animals are described as " indicators " or " revealers " because they show the presence of latent disease. Furthermore, sheep may be very resistant to disease and there is

FIGURE IV

NEUTRALISING ANTIBODY* RESPONSE OF CATTLE TO
INACTIVATED FOOT-AND-MOUTH DISEASE VACCINE



Antibody level is given as LOG $_{10}$ of the geometric mean titres of a number of sera.
The broken line indicates the level at which protection may be expected.

* Neutralising antibody gives an indication of protection.

ϕ Heterologous vaccine is prepared from a different but closely related strain from the one used to measure the antibody.

Source:- Ministry of Agriculture

a danger that they may harbour the virus for long periods; its presence would only become apparent when they come into contact with, and transmit the virus to, susceptible animals.

114. Young animals of all species can absorb antibodies from immune dams through colostrum (the first milk) in the first 24 to 36 hours of life. These maternal antibodies may confer protection, which varies from a few weeks to a few months, after which the young animals become completely susceptible. Maternal antibodies inhibit the response to vaccination and for this reason, in countries with general vaccination programmes, young animals are usually not vaccinated until they reach the age of four to six months when maternal immunity is lost. In the Federal Republic of Germany, however, calves aged two months are vaccinated on the assumption that either the animal is already protected by maternal antibodies, in which case the vaccine will not induce more protection, or that the animal is not immune and will respond satisfactorily with the development of antibodies.

115. In order to be successful a general vaccination scheme need not necessarily cover the entire susceptible livestock population of a country. A scheme covering a high proportion of the population, although not ensuring that every animal is immune, nevertheless builds up a national herd immunity which limits the number of primary outbreaks of foot-and-mouth disease and which breaks the chain of transmission of the virus, thereby also limiting the number of secondary outbreaks. In those countries in Europe where general vaccination has been adopted it is usual to protect only cattle.

116. The schedule of doses of foot-and-mouth disease vaccine varies in different countries. In France where animals are vaccinated only once a year, the operation is spread over the whole year so that the entire cattle population is never wholly susceptible. In the Netherlands vaccination takes place in the Spring, but any young animals that have attained the age of four months are vaccinated in the Autumn; other young animals are vaccinated as they are moved off the farm. In Argentina cattle are vaccinated three times a year and from the beginning of 1969 sheep are being included in the vaccination scheme.

117. In European countries vaccine is administered by veterinarians but in other countries, for example Argentina, the veterinary corps is insufficient in numbers to make this policy practicable and vaccination is supervised by local livestock committees which have farming and veterinary members.

118. The burden of cost of vaccination is spread in various ways but in general the farmer pays, either directly or through marketing or co-operative associations, in part or in whole. Where general vaccination is practised farmers appear to be satisfied that it constitutes a good insurance against the risk of infection and the consequential disturbance, loss of profits and, in some cases, of valuable livestock.

119. Many European countries employing general vaccination also employ a slaughter policy. Outbreaks of foot-and-mouth disease are dealt with by slaughtering the infected animals and sometimes those that have been in contact with them. These countries may also apply ring vaccination round the area of an outbreak, over a distance of from one to three miles. (See paragraph 123). These additional measures—slaughter and ring vaccination—have contributed

considerably to the success of general vaccination campaigns and may now be largely responsible for maintaining the improved situation. The vaccination campaigns in Belgium, France, the Federal Republic of Germany, the Netherlands and Switzerland have undoubtedly been successful, although these countries still have an epidemiological problem among their large susceptible pig population (see Table III).

Barrier Vaccination

120. Barrier vaccination involves the vaccination of all susceptible animals in a buffer zone to prevent foot-and-mouth disease spreading from one area to another. The successful application of barrier vaccination depends on the knowledge of the distribution and movement of the types and sub-types of the virus. The international agencies which help in this task are the Office International des Epizooties, (O.I.E.), the Pan American Foot-and-Mouth Disease Center, the European Foot-and-Mouth Disease Commission of the Food and Agriculture Organisation of the United Nations (F.A.O.), the Near East Animal Health Institute at Beirut (also part of F.A.O.) and the Inter-African Bureau for Animal Health. The Animal Virus Research Institute also assists in this work in its role as the international reference laboratory and is designated by F.A.O. as the World Reference Centre for typing and sub-typing of strains of foot-and-mouth disease virus. An example of barrier vaccination is to be found in Argentina, which maintains a buffer vaccination zone running east-west across the whole country to protect the provinces south of the Rio Negro; Denmark also uses barrier vaccination along its southern borders when there is a threat of the introduction of disease from northern Germany. Such vaccination may be carried out either with a monovalent vaccine if the type of virus is known, or otherwise with a polyvalent vaccine.

121. Barrier vaccination was successfully practised when, from 1962 onwards, south-east Europe was threatened with the introduction of the type SAT 1 virus which had not previously occurred on the Continent. Vaccination measures, co-ordinated by the European Economic Community, the Office International des Epizooties and the Food and Agriculture Organisation, were introduced to prevent the spread of the disease. In November, 1964 the disease situation on the south-eastern borders of Europe was further complicated by the emergence of the sub-type A_{22} virus which spread rapidly from east to west through the whole peninsula of Anatolia and reached Greece. Investigations showed that only the homologous sub-type A_{22} vaccine would prevent further spread into Europe. Supplies of such vaccine were produced for use in buffer zones in Bulgaria, Greece and Turkey. In addition a vaccination campaign with sub-type A_{22} vaccine was carried out in parts of Turkey. Many European countries contributed financially and by seconding staff; the United Kingdom Government supplied approximately £550,000 in cash and in vaccine. The measures taken successfully prevented the further invasion of Europe by type SAT 1 and sub-type A_{22} viruses.

122. In Mexico a rather different form of barrier vaccination contributed to the control of a foot-and-mouth disease epidemic which started at the end of 1946. Early efforts to control the disease by a slaughter policy met with only limited success and a vaccination policy was introduced in large quarantine

zones which were established by starting barriers fifty miles from known outbreaks and moving towards the source of infection. Eradication of the disease was accomplished by August, 1951.

Ring Vaccination

123. Control of foot-and-mouth disease by ring vaccination may be carried out in a country with a completely susceptible livestock population. It involves the vaccination of all susceptible animals in a prescribed area around an outbreak and depends for its success on the rapidity by which diagnosis, typing the virus and vaccination are carried out. If a suitable monovalent vaccine is available, consisting of the type or sub-type similar to that of the virus responsible for the outbreak, it would probably be used on these occasions; failing this a trivalent vaccine, if it contained the appropriate type of virus, might be used. Vaccination may be carried out in conjunction with slaughter of the infected animals and those that have been in contact with them.

124. Ring vaccination is practised in Denmark—a country which does not import carcase meat and which is not subject to many primary outbreaks. All cloven-hoofed animals on the affected farm are slaughtered unless they are judged to be immune as a result of previous vaccination. Cattle and sheep (but not pigs) within a perimeter of at least six miles are vaccinated and this is usually completed by local veterinary surgeons within ten days of the outbreak. Animals in the vaccinated area are retained within this area for some time; in the past this was usually several months but now the policy is that these animals may move out after thirty days. Restocking of cattle is permitted after disinfection of the farm on condition that the new stock have been vaccinated against the actual type of virus responsible for the outbreak at least three weeks and not more than two months before they are moved on to the farm. Restocking of pigs can take place six weeks after disinfection. Calves born on the farm have to be vaccinated at an age of three to four weeks, and the vaccination is repeated every fourth month for twelve months. There is a general rule that for five months after ring vaccination, cattle and sheep moving into the vaccinated area must have been vaccinated at the same time as, or after, the ring vaccination; however this rule may be waived. Some of the animals when vaccinated could be in the early incubation period of foot-and-mouth disease and a small proportion of them could become carriers of the virus. However, the prompt slaughter of the affected animals at an early stage before much virus is shed may mean that the carrier state arises in very few, if any, animals. The importance of the Danish experience is that no problem has arisen as a result of releasing cattle from within vaccinated areas and allowing them to mix with susceptible animals in other parts of Denmark.

(*b*) In Great Britain

Measures to control the introduction of foot-and-mouth disease virus

125. Precautionary measures to limit the introduction of foot-and-mouth disease into Great Britain are provided for in legislation or in agreements, as set out in Appendices V and VII. Orders are in force covering:

imported livestock;
imported meat and meat products;

imported meat wrapping materials;
imported hay, straw and grass;
imported semen;
imported sera and glandular products;
vehicles carrying livestock.

These control measures appear to have been generally effective except in regard to meat imports to which the Ministry of Agriculture have attributed the majority of foot-and-mouth disease outbreaks. We will therefore deal with this aspect in some detail.

126. The countries from which Great Britain imports meat fall into four categories:—

(i) countries free from foot-and-mouth disease, for example Australia and New Zealand, to which no restrictions are applied;

(ii) countries where the disease is sporadic and slaughter is included in the control policy, for example Denmark, France, the Netherlands and Poland. The conditions which are applied to such countries include the requirement that the origin of the animals and the place of slaughter shall be at least 20 kilometers (about 12½ miles) from any known outbreak of foot-and-mouth disease that has occurred within the last 28 days. A sudden upsurge in the number of outbreaks of the disease or a tendency for the disease to break out from controlled areas would call for immediate consideration of a general ban on imports from the country concerned. Imports are suspended when in the view of the veterinary authorities in Great Britain there is a risk of temporary loss of control over the disease;

(iii) countries or areas of countries in which the disease is sporadic and in which a slaughter policy is not normally practised but where movement control measures are adopted, for example South Africa. Conditions are imposed requiring certification that the origin of the animals is from regions which have been free from foot-and-mouth disease for at least six months;

(iv) countries where the disease is endemic and where the Bledisloe arrangements apply; these are Argentina, Brazil, Chile and Uruguay. (See Appendices VI and VII).

127. The Bledisloe arrangements were first introduced in 1928 and the four countries to which they apply, particularly Argentina and Uruguay, have exported large quantities of meat to Great Britain for a very long time. Under these arrangements these countries are permitted to export meat to Great Britain under less stringent animal health conditions than those which apply to other countries from which we import meat. The original Bledisloe arrangements (Appendix VI) were revised in October, 1968 (Appendix VII) following a visit to all four countries by a British veterinary mission. The revised arrangements require that only carcases from animals that have been properly vaccinated against foot-and-mouth disease shall be exported to Great Britain. Such animals are unlikely to develop infection if exposed to foot-and-mouth disease virus, or to harbour it, and therefore these revised arrangements will undoubtedly reduce the risk from meat imports.

128. Other additional disease precautions in regard to meat imports from these four countries have been introduced from time to time in the light of experience. In 1961 imports of pigmeat and pig offal were prohibited; this ban is still in force. In December, 1967—at the height of the 1967/1968 epidemic—a complete ban was imposed on the importation of South American meat and offal. On 15th April, 1968, the ban was removed from carcase beef and beef offal but was retained on imports of mutton and lamb including their offal.

129. The complete ban, imposed in December, 1967, was simultaneously applied to all other countries exporting meat to Great Britain with the exception of Australia, Canada, Finland, Iceland, New Zealand, Norway, the Republic of Ireland and the United States of America. As with the South American countries, the ban was removed on 15th April, 1968.

Control of outbreaks

130. Great Britain has relied on the slaughter policy for controlling foot-and-mouth disease since 1892 when an Act was passed authorising the Board of Agriculture to carry out compulsory slaughter. A serious epidemic occurred in 1922 and although the slaughter policy was generally applied, some of the affected herds were isolated where the circumstances were such as to provide what were then considered adequate safeguards against the spread of the disease. Isolation was abandoned in 1925 and since then the slaughter policy has been rigidly applied. This has been the means of reducing spread to the susceptible livestock population of Great Britain which in June, 1968 numbered about 44 million, including approximately 11 million cattle, 27 million sheep and 6 million pigs. In the following paragraphs we give a brief description of the slaughter policy as it applies in this country at present; there are many administrative arrangements involved and we shall return to these in Part II of our Report.

131. As soon as a suspected case of foot-and-mouth disease is reported the Ministry of Agriculture serves a notice on the farmer which prohibits movement on or off his farm except under the permit of the Ministry's veterinary inspector. The inspector then examines the animals and if necessary he arranges for specimens from them to be tested at the Animal Virus Research Institute. He may impose restrictions on an area of five miles radius of the suspected outbreak which prohibits movement of all animals within that area except under licence. If the case is confirmed, an Infected Area of approximately ten miles radius is immediately declared. The actual extent and perimeter of an Infected Area varies depending on the physical or legal boundaries by which it can be defined and the availability of slaughtering facilities. No movements of animals may take place within an Infected Area except under licence; such licences are issued either for direct movement to a farm (where the animals must remain for fourteen days without further movement) or from a farm to a slaughterhouse, or to a fatstock market for slaughter within the area. The Infected Area Order imposes other conditions relating to the movement of certain classes of persons, animals and materials within an Infected Area. No licences may be issued for movement of animals out of an Infected Area.

132. Where there might have been widespread dissemination of the disease, such as through a market or a dealer's premises, it may be necessary to impose wider restrictions, that is Controlled Area restrictions, which prohibit movements and markets without a licence. The object of these wider restrictions is to control movements until animals that may have been in contact with infected stock have been traced and inspected by the Ministry's veterinary staff.

133. Infected animals are slaughtered immediately the disease is confirmed; the remaining animals on the farm are slaughtered after valuation. The carcases are buried or, in certain cases where burial is not practicable, are burnt.

134. Formerly the carcases of animals which had been in contact with infected animals but which were at the time of slaughter apparently healthy were salvaged in Great Britain but this practice had been abandoned by 1927. Salvage was reintroduced during the second World War but it was condemned in the Gowers Report and thereafter was no longer practised. Cases have been recorded of infected material from salvaged carcases being introduced into swill and thus giving rise to further outbreaks. The Gowers Committee recorded the following incident—

> " The first case of the exceptionally severe epidemic in Dumfriesshire was reported on the 2nd June [1952], in pigs owned by a dairy company at Holywood. The next day outbreaks occurred on two adjoining farms as well as at Lockerbie, some ten miles away. The evidence available indicated that these three outbreaks were either spread from the Holywood dairy or had a common origin with the outbreak there. That origin appeared to be meat salvaged from the outbreaks at Wigtown which was sent via a Dumfries butcher to a school-meal kitchen at Marchmont, Dumfries. Kitchen waste found its way to a piggery (about half a mile from the dairy company's premises) where it was stored, unboiled, in bins in the open. Rooks abound in the neighbourhood, and it is known that they frequently fed from these swill bins. It is likely that they carried the infection to the dairy company, since there also the birds feed from feeding troughs in the open. Thirty-seven outbreaks followed in the vicinity of Dumfries ".

135. In isolated outbreaks of disease restocking of the infected farm is allowed 28 days after final disinfection or 42 days after slaughter, whichever is the earlier; but when there has been a number of outbreaks in close proximity these times for restocking relate to the time of the last outbreak in the area. It is usual to reduce the size of an Infected Area to about five miles round the infected farm fourteen days after the last outbreak and to remove restrictions after 21 days. Controlled Area restrictions are removed as soon as possible in order to permit livestock trading to be resumed.

136. Preparations for the emergency use of vaccine were made during the 1967/1968 epidemic. During the second half of November, 1967 it was decided to prepare contingency plans for an extensive ring vaccination programme as a second line of defence. A stock of type 0_1 monovalent vaccine

was acquired and a plan of campaign was drawn up in the first few days of December. Some five hundred veterinary surgeons who were not employed in the foot-and-mouth disease control programme were prepared to leave their normal work and commence vaccination. The plan assumed that full scale vaccination could be started within four days of a decision being taken to vaccinate and that about two million animals could have been vaccinated in ten days. In the event, the plan was not necessary as during December it became apparent that the epidemic was waning.

CHAPTER VII

DISCUSSION OF FUTURE POLICIES FOR GREAT BRITAIN

137. There are three main policies for dealing with the prevention and control of foot-and-mouth disease which can be adopted either singly or in combination:

(*a*) *Import policy*—designed to reduce the risks of introducing the disease into the country by restrictions on imports which may carry the virus.

(*b*) *Slaughter policy*—designed to isolate and stamp out outbreaks of the disease when they occur.

(*c*) *Vaccination policy*—designed either to limit the number of primary outbreaks as well as the subsequent spread (general prophylactic vaccination), or solely to limit the spread of the disease when primary outbreaks occur (ring vaccination).

(*a*) Import Policy

138. There are a number of ways by which foot-and-mouth disease may be introduced into Great Britain; they have all been referred to in previous chapters and may be summarized as follows:

(i) wind tracks carrying airborne virus;
(ii) migratory birds;
(iii) travellers coming from abroad;
(iv) traffic from abroad;
(v) importation of semen;
(vi) importation of sera and glandular products;
(vii) importation of hay, straw and other vegetable matter;
(viii) importation of live animals;
(ix) importation of meat wrappings which may have been exposed to the risk of contamination by the virus;
(x) importation of meat and meat products.

139. The introduction of foot-and-mouth disease virus by wind and birds cannot be controlled. However, the improved situation regarding foot-and-mouth disease in the northern parts of the Continent of Europe over the past few years undoubtedly has reduced the risks from these methods of introduction and has probably been responsible for the reduction of the number of primary outbreaks in the east and south coastal areas of England. There are no suitable wind tracks or migrations from countries such as Spain. All our witnesses thought that the risk of introduction from Continental sources by wind and birds is now small.

140. International travel for business and pleasure is increasing every year. This trend is likely to continue. In 1957 the number of foreign visitors arriving in this country was about $1\frac{1}{4}$ million and by 1967 the number had increased to nearly $3\frac{1}{2}$ million; over 2 million of those who landed in 1967 arrived by

air. The number of British travellers abroad has also increased; in 1957 nearly 3 million of them returned to the United Kingdom and by 1967 this figure had increased to about $6\frac{1}{2}$ million. About 4 million of those who landed in 1967 arrived by air. All our witnesses acknowledged that there could be a risk of foot-and-mouth disease transmission from country to country by travellers although none rated it very highly. It seems that this risk may not be great but transmission of the virus by this means would often be impossible to prove. Although with the rising volume of travel the risk could increase, we think that satisfactory foot-and-mouth disease control programmes overseas will certainly reduce it. Some countries free of foot-and-mouth disease have taken elaborate precautions, when threatened with the introduction of the disease, to inspect passengers and baggage at the port of entry and to ensure that they pass through a decontamination barrier, but we consider that to do this effectively would be impracticable because of the magnitude of the problem.

141. The risk of introducing foot-and-mouth disease arising from vehicular traffic from abroad has also increased. This risk is greatest when animals or other potentially dangerous materials are transported. There are Statutory Orders (see Appendix V) dealing with this matter which require the cleansing and disinfection of vehicles which have carried animals before they are used to carry other animals; these requirements, however, might not necessarily be implemented until vehicles have travelled far inland. We consider that such vehicles should be cleansed and disinfected at the ports of entry and that the present facilities for doing so are inadequate. Facilities should also be available for disinfection of personnel who come in contact with such vehicles.

142. The importation of semen, sera and glandular products and the importation of hay, straw and other vegetable matter is dealt with in Great Britain by legislation (see Appendix V). It was considered by all our expert witnesses that the importation of these materials under present legislation does not constitute a serious risk of introducing foot-and-mouth disease virus.

143. One of the major risks of introducing foot-and-mouth disease virus into Great Britain could be from the importation of live animals susceptible to foot-and-mouth disease. In this respect Great Britain exercises rigid control procedures (see Appendix V) which have apparently been successful in preventing the introduction of the disease by this means. There has never been an outbreak associated with animals imported under these Regulations, and our witnesses agreed that little or no risk was involved under present legislation.

144. The importation of meat, meat products and meat wrappings constitutes a serious risk particularly in relation to bones and offal (see paragraph 14). We think that the way in which offal is treated makes the risk from this source less than the risk from bones; in general there is little waste thrown away from offal before it is cooked. We accept however that tainted offal might be thrown away without having been cooked and there is also a risk from wrappings and residual blood from offal.

145. Great Britain imports meat and meat products from countries which are completely free from foot-and-mouth disease, such as Australia and New Zealand, from countries where the disease is sporadic, and also from countries where it is endemic. There is no risk of introducing the disease by the importation of meat and meat products from countries which are free from the

disease, but there are differing degrees of risk when imports are from countries where the disease is endemic or sporadic, depending on their disease status.

146. The quantity and type of meat and meat products imported into Great Britain from countries where foot-and-mouth disease is sporadic are included in Appendix VIII. Such imports carry a risk of introducing the disease and although strict control legislation (see Appendix V) is enforced, there clearly remains a potential risk in importing meat and meat products from countries suffering from sporadic outbreaks. This risk would diminish as the animal health situation in such countries improves. Effective controls must depend on the ability at short notice to revoke licences whenever dangerous situations arise in exporting countries. We consider it essential that the importation of meat and meat products should be governed by a machinery which is sufficiently flexible to cope swiftly and adequately with the many differing and often fast changing situations which can arise in these countries. We are satisfied that the general use of revocable conditional licences must be accepted as the only satisfactory means of providing this essential flexibility.

147. The figures of meat imports given in Appendix VIII also include those from countries where the disease is endemic, namely Argentina, Brazil, Chile and Uruguay. We consider that the risk of introducing foot-and-mouth disease into Great Britain in respect of imports from these countries is always high. We have explained in Chapter II that foot-and-mouth disease virus can remain viable in various parts of an infected carcase for long periods and although the virus has been isolated from meat responsible for an outbreak of the disease on only one occasion in Great Britain, we are satisfied that the majority of primary outbreaks in this country have been caused by imported meat from countries where the disease is endemic.

148. Table X overleaf gives the origins to which the Ministry of Agriculture attributes the primary outbreaks of foot-and-mouth disease in the period 1954 to September, 1967. Of the 179 primary outbreaks, 74 (41 per cent) were attributed to imported meat and meat wrappings from countries where the disease was endemic. It may well be that some of the 40 outbreaks (22 per cent of the total) to which no origin could be attributed were also from meat sources.

149. Great Britain has recognised for a long time the danger of importing meat from Argentina, Brazil, Chile and Uruguay and over the years has made arrangements and imposed certain restrictions regarding meat imports from these countries to reduce the risks (see paragraph 127 and Appendix VI). The situation before the 1967/1968 epidemic was that beef, lamb and mutton, together with their offal, could be imported under the Bledisloe arrangements but there was a complete ban on the importation of pig meat and pig offal.

150. At the height of the 1967/1968 epidemic further restrictions were imposed on meat imports from Argentina, Brazil, Chile and Uruguay (see paragraph 128). In April, 1968 restrictions on imports of carcase beef and offal were removed but the bans on pigmeat and offal, and mutton and lamb and their offal, have remained in force. Further, as a result of a veterinary mission which visited these countries in May, 1968, the Bledisloe arrangements were revised and put into operation in their new form in October,1968 (see Appendix VII).

TABLE X

Origins Attributed by the Ministry of Agriculture to Foot-and-Mouth Disease Outbreaks from 1954 to September, 1967

Year	Primary Outbreaks	Attributed by Ministry of Agriculture to:				
		Imported Meat and Meat Wrappings			Birds and other Origins	Origin Obscure
		From countries where the disease is:		From unidentified countries		
		Endemic	Sporadic			
1954	8	8	—	—	—	—
1955	7	6	—	—	—	1
1956	32	13	—	4	10	5
1957	43	13	1	9	17	3
1958	29	8	—	2	13	6
1959	9	3	—	3	1	2
1960	26	12	—	1	1	12
1961	18	7	3	—	—	8
1962	2	2	—	—	—	—
1963/1964 ..	—	—	—	—	—	—
1965	1	—	—	—	—	1
1966	2	—	—	—	—	2
1967*	2	2	—	—	—	—
Totals	179	74	4	19	42	40

* January to September.

151. We have considered what additional modifications in the import policy could be introduced in order still further to reduce the risk of introducing foot-and-mouth disease into Great Britain. The existing policies, except in relation to meat from countries where the disease is endemic, were considered satisfactory. They should not however be regarded with complacency; constant surveillance should be exercised to ensure that their present effectiveness is maintained.

152. With regard to the importation of meat from countries where the disease is endemic the most effective policy would be a ban on chilled and frozen beef and beef offal; this, together with existing bans on pork, mutton and lamb and their offal, would amount to a total ban on all carcase meat and unprocessed offal from these countries. We are impressed by the freedom which countries such as Canada, Northern Ireland, the Republic of Ireland and the U.S.A. have had from the disease as a result of such a policy.

153. A number of organisations stated in evidence that a total and lasting ban on meat imports from countries where foot-and-mouth disease is endemic would give rise to supply problems, and so to pressure on prices, for a period of some years. Judgments on the social, political, and commercial implications of a ban on meat imports do not fall within our terms of reference but we feel it would be appropriate to describe the broad pattern of United Kingdom meat supplies and meat marketing which emerges from the evidence.

154. In 1967, 28 per cent of the total United Kingdom supply of carcase meat and offal (beef, veal, mutton, lamb and pork) was imported; this was valued at about £162 million c.i.f. Within the total United Kingdom supply figure, the import situation varied between different types of meat. About two per cent of the total tonnage of pork, 23 per cent of the total tonnage of beef and veal, and 57 per cent of the total tonnage of mutton and lamb were imported. Some 40 per cent of total offal supplies was imported, to the value of about £22 million c.i.f..

155. In the United Kingdom, beef production is still subject to a considerable seasonal variation with supplies in October and November about 33 per cent greater than in June and July. Grass-fattened cattle, marketed in the autumn, have a cheap finishing period in contrast with the more expensive fattening of cattle through the winter for the marketing in the Spring. In both cases, however, the fattener derives his beef store cattle from two main sources:

(i) store cattle from the United Kingdom beef and dairy herds;

(ii) the Republic of Ireland (620,000 head in 1967, of which about 200,000 entered Northern Ireland).

Physically similar conditions and close economic integration, particularly in the meat and livestock sector, result in the seasonal production pattern of the Republic of Ireland following, and hence accentuating, that of the United Kingdom. Lamb production in the United Kingdom depends even more upon the seasons than beef, with the bulk of marketings in the second half of the year. Sheep are marketed fat in a similar annual pattern. Pig production meets the requirements of the market for pork and manufactured products as well as a significant share of the bacon market; it is not subject to any natural seasonal conditions or variations. Supplies of all poultry meats in 1967 totalled some 438,000 tons, almost entirely home production, which has been increasing over the last few years at the rate of about ten per cent per annum. In contrast to cattle and sheep, home production of pigmeat could be expanded greatly and quickly because of the short production cycle, the prolificacy of the pig and its limited direct requirement for land. Production of poultry meats could also be greatly expanded at comparatively short notice to meet demand. Thus the scope for increased home production in the short-term would depend primarily on poultry and pigmeat. An increase in beef, mutton and lamb would take significantly longer.

156. Fatstock, both cattle and sheep, are sold mainly through about 600 regular liveweight auction markets which are approved certification centres under the Fatstock Guarantee Scheme. There are some hundreds of other markets which are not approved certification centres. Some liveweight sales by private treaty take place but in quantities of minor importance. The other major method of marketing is sale by deadweight at a slaughterhouse of which there are over 2,000; about a half of these are approved certification centres. Buyers include retail butchers, wholesalers and dealers; local retail butchers may buy to cater for local demand. More important in total are the buyers who are catering for the large urban demands throughout the country. These buyers, whether multiple retailers, wholesalers or dealers, will be buying to supply numerous retail outlets and they may buy from few sources or many, according to their judgments of how demand can most profitably be met. Retailers may buy at points of first sale, or from wholesalers, or from dealers

capable of satisfying their particular requirements. Thus marketing runs in some well established channels, which result from individual businesses keeping to arrangements they find satisfactory rather than from any specific links between types of buyers and sources of supply.

157. As regards overseas suppliers and retailers in this country, the links are different and just as diverse. Beef is imported fresh, chilled and frozen. Fresh beef is supplied from the Republic of Ireland, in the form of fat cattle for immediate slaughter, or as carcase beef and the meat must be marketed within the same time as home production. Chilled beef can be preserved for a few weeks with care and cost, but has to be marketed quickly once it is taken from the ship. Frozen beef can be stored for longer, up to a year, and is transferred from the ships hold to a cold store in the United Kingdom. Most imported lamb comes frozen from New Zealand (in 1967, nearly 300,000 tons out of total imports of nearly 340,000 tons) and can also be put into cold store on arrival in this country. The quantity marketed or retained in cold store on arrival depends on the time of the year and the state of the market.

158. The major supplier of chilled beef has been Argentina. This trade has been conducted on a consignment basis, sold on commission in the United Kingdom. There are in this trade firms who conduct all the operations from purchase of cattle, through slaughter and shipping, to sale in the home market. The final sale may be through their own retail outlets, wholesale by private treaty, or through a wholesale market such as Smithfield. Chilled beef is widely accepted as an alternative to fresh beef and hence is in competition with it, although sold at about 3d. per lb. less at the wholesale level. Chilled beef is therefore sold at prices according to the state of the fresh meat market a few days after its arrival in the United Kingdom. Those engaged in the trade have had to judge the market some four to six weeks ahead, in the light of probable competition, particularly from home and Irish beef supplies, but also from other meats. The price paid to Argentinian producers depends largely on those traders' judgments. South American countries, like other southern hemisphere suppliers, produce the main part of their fatstock between January and June, and thereby complement home produced and Irish grass-fed supplies. The contribution of South American countries to United Kingdom meat supplies, which was about ten per cent of the total in 1967, fluctuates between four and twenty per cent at different times of the year. Also, the demand for imported meat is higher in some parts of the country than in others; in Smithfield Market, for example, in recent years, beef and veal from South America has amounted to about forty per cent of the total quantities of such meat passing through the market annually.

159. Frozen beef has been imported mainly from Australia, South America, and New Zealand; there has also been a number of minor suppliers. Frozen beef is not competing directly with fresh or chilled beef; it goes mainly to catering and manufacturing uses, and at much lower prices. The slaughter of cattle for this trade shows a seasonal variation but the possibility of storing the meat makes its issue from store onto the home market depend largely on the state of the market. Some frozen beef is shipped in boneless cuts and there is a market preference for this.

160. New Zealand lamb is produced fat between December and July, with a peak from January to March. Shipments are made to the United Kingdom

during this period and issues from cold stores here are governed by the state of the market. New Zealand lamb is highly competitive with home produced lamb and it is sold for most of the year at a lower price.

161. Several countries supplying meat to the United Kingdom have their own organisations which oversee and aid their exports. However the trade is also conducted by firms which purchase overseas, and ship and wholesale in this country both by private treaty and on the wholesale markets. In addition some overseas shippers sell through agents in the United Kingdom. Thus most imported meat is sold here by firms which are directly concerned with marketing in the United Kingdom and form an integral part of the wholesale trade. Some of the firms are further integrated in that trade in that they deal with both home produced and imported supplies.

162. Under the Bledisloe arrangements, the South American meat suppliers have been permitted to export considerable quantities of meat to this country under less stringent animal health safeguards than are applied to other exporting countries. This has no doubt been done for trade, supply and price reasons. The cessation of supplies from South America would entail the loss of perhaps as much as 140,000 tons of beef and veal, which is under ten per cent of present annual United Kingdom consumption; this would include 120,000 tons from Argentina (which might be valued at about £25 million c.i.f.) and 10,000 tons of beef from Uruguay (worth £2-£2½ million). About 15 per cent (worth about £2 million) of the total supply of imported offal would also be lost. This might be replaced, probably with a marked price effect, from other countries. The main problem would arise over chilled beef which initially at any rate could only be replaced to some extent by supplies from European sources. It might take some years for such a trade to build up to really adequate proportions. If full replacement were needed, it would have to be met largely by increased home production, more particularly of pork and poultry meat in the short run, but of beef here and in Ireland in the longer run.

163. Chilled beef, of which Argentina has been our largest supplier and for which we have been her principal customer, is acceptable at retail as an alternative to fresh beef. It is usually cheaper cut for cut than home killed beef of similar quality. A shortage of this meat would in the short-term increase the prices of beef in particular and of other meats generally. In the longer term, assuming a switch in demand to pigmeat and table poultry and the scope for increased production and imports suggested above, the effect would be for the price increase to be reduced but still to remain above the level which—other things being equal—might otherwise have prevailed. Many of our witnesses thought that the effect might be to divert consumers from beef to the detriment of livestock enterprises in this country.

164. In addition to the economic considerations above there are social and political considerations which may make it impracticable to apply a total ban on all carcase meat and unprocessed offal from countries where foot-and-mouth disease is endemic; in view of this we outline in the next paragraph an alternative modification to import policy.

165. We have pointed out in paragraphs 14 to 17 that the most likely way in which the foot-and-mouth disease virus is introduced into this country is in the bone marrow, offal and lymphatic glands of infected carcases. Further

we have been advised that if the import policy were to allow for the importation of only boned-out meat, and offal which had been processed in such a way as to destroy the virus, the risk of introducing the virus would be substantially reduced. If the present import policy were modified in this way we think its effect in reducing the risk would be almost equivalent to a complete ban.

166. We have taken evidence from meat exporting and importing organisations about the practical problems involved in sending boned-out meat to this country. The trade in boned-out meat from South America is already quite substantial. In 1968, for example, our imports of boned and boneless chilled or frozen beef and veal from South American countries amounted to 3,110 tons, that is about 5 per cent of their total exports of beef and veal to the United Kingdom in that year. It follows that some exporters in South America are already equipped to carry on this trade. Such equipment requires considerable capital investment, and a further extension of this trade would probably involve some alteration to shipping arrangements.

167. There are two obstacles in the present trading arrangements that would impede the natural development of trade in boned-out meat. At present boned-out beef and veal from countries not enjoying Commonwealth preference attracts 20 per cent duty as opposed to a duty of about 3 per cent applying to chilled, fresh or frozen beef and veal carcases. If a boned-out meat policy were to be adopted we consider that it would be essential that the Government should adjust the import duties on meat so as to remove the current discrimination against boned-out beef.

168. The second obstacle concerns new Regulations which were introduced in August, 1968 governing the inspection of imported food including meat; they replaced Regulations which had been in force since 1937. The earlier Regulations permitted meat to be imported without lymphatic glands if these were necessarily removed in the preparation of the meat. Increasing trade meant that more meat was being imported without these glands and because of the risk to public health it was considered that this trend should not be allowed to continue. (Inspection of glands is used in assessing the fitness of food for human consumption.) The new Regulations require that some cuts of meat, particularly boneless, which could previously be imported without lymphatic glands, must now have the glands attached to them. The Regulations provide for exemptions where conditions in the meat plants justify them; so far no South American establishments have been exempted. The inclusion of lymphatic glands in consignments of boned-out meat would undermine the purpose of a boned-out meat policy since lymphatic glands may harbour the foot-and-mouth disease virus (see paragraph 14); it would be necessary to impress upon the Governments of these meat exporting countries the importance of attaining a high enough standard of hygiene for establishments to earn exemption. Two veterinary attaches in Buenos Aires maintain liaison with Argentina, Brazil, Chile and Uruguay on the animal health and public health aspects of the meat trade. This we consider inadequate bearing in mind the magnitude of the operation and the distances involved. If the complement were increased it would enable the attaches to make a more effective contribution to the attainment of the high standards referred to above. An increase in the complement would also strengthen the operation of the Bledisloe arrangements.

169. Another obstacle that might impede the development of a boned-out meat policy was brought to our attention by the representatives of meat wholesalers and retailers in this country. They pointed out that consumers' preferences varied and that butchers cut their meat in a number of different ways according to locality; they considered therefore that the enforced imposition on the consumer of imported meat in the form of boned-out meat packs would be less acceptable both to the trade and to the housewife. Notwithstanding these objections, there is a trend in current commercial practice away from the exportation of carcase sides towards boned-out cuts, and in any case a boned-out meat policy would only affect what is at present about ten per cent of our total domestic consumption of beef.

170. Certain food processors in this country suggested to us that, if there were to be any restriction on the importation of carcase beef and offal from countries where foot-and-mouth disease is endemic, a system of licensing might be devised to allow imports to continue to certain establishments in Great Britain who undertook to adopt adequate precautionary measures. It is questionable whether a satisfactory system of licensing could be devised.

171. Another suggestion made to us was that the distribution of carcases imported from countries where foot-and-mouth disease is endemic should be confined to urban areas. The primary distribution of chilled beef from Argentina already conforms in the main to this pattern. To impose such an arrangement on all supplies of carcase meat from countries where the disease is endemic would require policing not only of primary but also of subsequent distribution, and we consider this to be impracticable.

172. We examined the application of irradiation as a means of eliminating foot-and-mouth disease virus from meat. A major problem would be that of establishing the wholesomeness of the irradiated product, and even if this were achieved the public would have to be persuaded to accept it. We do not therefore think this method of control has any practical application at present.

(*b*) Slaughter Policy

173. The slaughter policy has been applied in controlling the spread of foot-and-mouth disease in Great Britain for the greater part of this century. The procedures involved in carrying it out have already been briefly described in Chapter VI. Although there have been repeated outbreaks, including some major epidemics over the years, the slaughter policy has been highly successful in limiting the extent of almost all the outbreaks, and on all occasions it has been the major factor in eradicating the disease, and eliminating the virus, from this country. In short, the slaughter policy has prevented the disease from becoming endemic in Great Britain.

174. The annual costs in compensation for the slaughter of livestock from 1954 until 1968 are set out in Table XI opposite. Although in some years the cost of compensation was high, the annual average over the period (but not including 1967/1968) was about £$\frac{1}{2}$ million. The cost of an outbreak, however, cannot merely be assessed in terms of compensation. Other factors must also be taken into account such as consequential losses and disturbance to the agricultural and other industries, as well as to many activities which are

indirectly affected. These factors were discussed in our assessment of the cost of the 1967/1968 epidemic (see paragraphs 97 to 101).

TABLE XI

Annual Cost of Compensation for Slaughter of Livestock, Resulting from Foot-and-Mouth Disease, 1954 to 1968

Year	Outbreaks	Animals Slaughtered					Compensation
		Cattle	Sheep	Pigs	Goats	Total	
1954.. ..	12	527	377	391	0	1,295	£41,068
1955.. ..	9	664	713	241	5	1,623	£55,940
1956.. ..	162	10,547	13,123	4,793	42	28,505	£824,658
1957.. ..	184	11,284	12,885	6,221	20	30,410	£880,586
1958.. ..	116	9,529	2,442	8,008	24	20,003	£869,563
1959.. ..	45	2,251	2,284	3,179	3	7,717	£225,370
1960.. ..	298	26,045	32,493	12,031	24	70,593	£2,120,745
1961.. ..	103	7,078	9,813	8,149	9	25,049	£679,540
1962.. ..	5	371	273	308	0	952	£26,869
1963.. ..	0	0	0	0	0	0	0
1964.. ..	0	0	0	0	0	0	0
1965.. ..	1	154	0	0	0	154	£18,895
1966.. ..	34	5,964	38,607	718	2	45,291	£933,249
1967.. ..	2,210	196,771	97,253	113,267	50	407,341	£24,621,578
1968.. ..	187	18,096	11,582	5,259	7	34,944	£2,356,219*

* Provisional figure.

Source:- Ministry of Agriculture

175. We consider, as did nearly all our witnesses, that the slaughter policy has been an essential measure in controlling foot-and-mouth disease in Great Britain, and that irrespective of whether a vaccination policy were adopted, slaughter would need to be continued. Nevertheless we recognise the consequences of this policy to farmers and to those who have to implement it. We fully subscribe to the views expressed by the Gowers Committee who wrote as follows:

> " We wish to make it clear at the outset that we are not among those who regard stamping-out [the slaughter policy] with complacency. We sympathise with the widely expressed view that it is a crude and primitive way of dealing with a disease. We know what a harrowing duty it is for the officers of the Ministry who have to carry it out. We recognise the mental anguish it may cause to those who suffer its consequences, and the shattering disaster, not computable in terms of money, that it may bring to a farmer who has to see the work of a lifetime destroyed in a day."

(*c*) Vaccination Policy

176. In the previous chapter we have described the vaccination procedures practised in various countries under their foot-and-mouth disease control

programmes, and in the following paragraphs we outline the way in which such procedures might be applied in Great Britain. We will deal with this aspect under five headings:

(i) general prophylactic vaccination;

(ii) ring vaccination following an outbreak of foot-and-mouth disease;

(iii) emergency ring vaccination;

(iv) barrier vaccination;

(v) prophylactic area vaccination.

General Prophylactic Vaccination

177. The Ministry of Agriculture pointed out that before compulsory general prophylactic vaccination for foot-and-mouth disease could be introduced in Great Britain, an amendment to the Diseases of Animals Act, 1950 would be necessary. An Order under the amended Act would also be required.

178. We describe in broad outline one of the ways in which general vaccination might be applied in Great Britain. For this purpose the following assumptions have been adopted:

(i) All cattle and sheep over three months of age, but not pigs, would be vaccinated regularly.

(ii) If an outbreak occurred the slaughter policy would be applied and all clinically affected animals and animals with which they had been in contact would be destroyed.

(iii) When an outbreak occurred all cattle, sheep and pigs in an area approximately five miles around it would be vaccinated.

(iv) Vaccination would be under veterinary control.

179. Under such a scheme about 10 million cattle and about 21 million sheep would have to be vaccinated. In the first year two doses of vaccine would be given in order to achieve as rapidly as possible a satisfactory level of immunity. Thereafter one dose of vaccine would be given each year. Similarly young stock would be vaccinated twice in twelve months once they had reached three months of age, and then annually. Trivalent inactivated vaccine containing types A, C, & O virus would be used since these types are present in Europe and South America (see Map I).

180. Vaccination would be carried out by local veterinary inspectors or by lay assistants under their supervision. Inspection of livestock prior to vaccination would be essential to detect any low grade infection that might be present in herds and flocks.

181. Primary outbreaks of foot-and-mouth disease, with secondary spread, could still occur as the immunity conferred by general vaccination would be by no means absolute. It would be impossible to keep all livestock completely protected at all times, and pigs, which are highly susceptible to the disease, would still be at risk. Nevertheless, raising the resistance of the national herd should reduce the number of outbreaks to some extent in the first year of the vaccination scheme and to a substantial extent subsequently.

182. Outbreaks of foot-and-mouth disease would continue to be dealt with by the slaughter of all infected animals and animals that had been in contact with them. Sanitary control and restriction of movement of animals would also be enforced. In addition, ring vaccination with appropriate monovalent vaccine (see paragraph 123), of all susceptible stock over the minimum age within a radius of five miles from the Infected Premises would be carried out, together with veterinary inspection of stock. The veterinary resources of the area would be utilised but it might be necessary to bring in additional vaccination teams. There would be some delay in starting ring vaccination but it would probably be complete within seven days of the occurrence of the outbreak.

183. In the field, regional veterinary officers of the Ministry of Agriculture would ensure that vaccination programmes were devised and implemented. At the ports receiving cattle from Ireland, the Ministry's veterinary officer in charge would ensure that all imported store cattle and sheep were vaccinated; the number would amount to about 400,000 head of livestock each year.

184. After the first injection of vaccine and before the second dose had been given, control measures similar to the present ones would be maintained in the event of an outbreak of foot-and-mouth disease. The slaughter policy would be implemented to the same degree as at present and restrictions relating to Infected Areas would operate. Local control centres would be set up and the staff in charge, in addition to their normal duties, would be responsible for ring vaccination. The present routine patrol system of inspecting stock in a two-mile ring round an infected farm could be replaced by a clinical examination at the time of vaccination in a five-mile ring. Because of the possibility that vaccinated animals that had been exposed to infection might develop a mild form of the disease without showing obvious clinical signs, it would be necessary to carry out subsequent routine inspections of the vaccinated animals.

185. After the second dose had been given the immunity developed in the national herd should allow modification of the existing control measures in the event of an outbreak of foot-and-mouth disease. The slaughter policy, and procedures on Infected Premises, would be continued, but restrictions relating to Infected Areas could be much less rigid and applied only to the areas covered by ring vaccination. Infected Areas would be maintained for 28 days to allow time for the completion of ring vaccination and the development of satisfactory immunity.

186. It would be essential that vaccine used in a vaccination scheme should be both safe and efficaceous; detailed methods of production and control would have to be formulated and embodied in Regulations. Only those batches of vaccine which complied with the Regulations and which had been approved by the licensing authority (the Ministry of Agriculture) would be used.

187. A control laboratory acting on behalf of the Ministry of Agriculture would carry out tests on batches of the finished product and on samples taken at various stages in the process of manufacture. The Animal Virus Research Institute would probably be the most suitable place for a control laboratory. The facilities would, however, have to be expanded since the work on control should be entirely separate from that of other work in the Institute in order to avoid cross-contamination which might invalidate the results of control tests.

188. In formulating Regulations, important factors would have to be taken into consideration, as follows:

(i) the strains of foot-and-mouth disease virus to be used;

(ii) the tissue substrate for cultivating the virus;

(iii) the initial concentration of live virus particles;

(iv) the method of inactivation of virus;

(v) tests for inactivation (safety);

(vi) tests for antigenicity (immunizing power).

It was clear from the evidence we obtained from experts in the field of vaccine production and control that considerable divergence of opinion existed regarding some of the above factors. It was also clear that some of the procedures at present employed are by no means satisfactory. For example, in some laboratories inactivation of virus by formaldehyde is carried out in the presence of an aluminium adjuvant, a process which in our opinion does not lend itself to a safe final product. An advisory body to the Ministry of Agriculture, consisting of expert virologists with knowledge of viral vaccines, would be desirable to advise on the formulation of Regulations. This body would also advise on the acceptability of new manufacturing and control procedures as they arose.

189. General prophylactic vaccination need not necessarily cover the entire susceptible livestock population in order to be successful (see paragraph 115); but it would be ideal if a coverage of 70 to 80 per cent were achieved. In most countries employing prophylactic vaccination only cattle are vaccinated and in general this affords an adequate coverage. In Great Britain however vaccination of cattle only would cover 25 per cent of the livestock population and it would therefore be necessary to vaccinate both the sheep and cattle populations for vaccination to be effective. Such a coverage could reduce both primary and secondary outbreaks of foot-and-mouth disease. Any outbreaks that might occur would probably be in pigs, young sheep and calves.

190. One of the problems associated with vaccination is that it might induce in some animals an anaphylactic type reaction (sensitivity to the injection of foreign protein). We do not know the frequency of these reactions; the factors present in the vaccine which may be responsible for them have not yet been clearly defined. This is a problem that needs further investigation and one which must be taken into consideration when embarking on a vaccination scheme.

191. A general vaccination policy in Great Britain would be costly as about 30 million cattle and sheep over three months old would need to be vaccinated twice in the first year and thereafter annually. Further, in the event of an outbreak of foot-and-mouth disease, all the animals included in a prescribed area around the outbreak would be vaccinated. It has been estimated that during the first year of the scheme, the cost of general vaccination, with additional vaccination in the event of outbreaks and with provision for the costs of slaughter, might be of the order of £13 million and in succeeding years about £5 million. The general vaccination would account for about 90 per cent of these total annual costs. In 1954 the cost of general vaccination of cattle, sheep and pigs was given in the Gowers Report as a range from £24 million to £56 million per annum of which £10 million to £23 million related to vaccination of cattle. General vaccination would be cheaper today partly because vaccines

are now likely to be less costly and also because, except in the first year, vaccination would take place annually. In 1954 it was considered necessary to vaccinate animals at four monthly intervals.

192. There would also be a heavy cost in manpower. A considerable number of veterinarians would be required to implement the scheme and as a result they would not be available for other important veterinary work. There would also be a considerable diversion of effort for farmers in rounding up herds and flocks and mustering animals for vaccination. Farms have increased in size without a proportionate increase in manpower, and the handling of individual animals presents problems. The population of sheep in Great Britain in the Autumn is about 20 million and these would have to be included in the vaccination programme because of their close contact with other farm animals. This could present practical difficulties, particularly because many of them are in hill flocks. Moreover vaccination would be difficult to justify in some areas where the disease has been completely absent for many years.

193. Another problem would arise from the considerable movement of cattle in Great Britain. The fear has been expressed that because of this, many animals would be missed in a scheme of general vaccination. This problem could only be overcome by the costly procedure of identifying individual animals.

194. It has been claimed that any form of vaccination in Great Britain would deprive the country of some of its valuable export markets in livestock because of the possibility that vaccinated animals might be carriers of the virus. Although we do not think that there would be a high risk of transmission of the disease to other countries by carrier animals we nevertheless recognise that it would be difficult to overcome the traditional attitude of many countries importing livestock, to receiving breeding stock from vaccinated herds. There would be no problem in relation to those countries where vaccination is practised, but in other countries there could be resistance. A system similar to that in use for exporting cattle from Europe to Canada might have to be adopted. This system allows the importation of young animals subject to testing for the presence of the virus, before they are moved from the country of origin and again while held in quarantine in suitable premises on arrival at their destination. The level of United Kingdom livestock exports during 1965 to 1967 is given in Table XII. In 1967 the value of these exports was about £1·2 million.

TABLE XII

Exports from Great Britain of live animals for breeding

(head)

Receiving country	1965		1966		1967	
Irish Republic ..	4,786 cattle 5,358 sheep	10,144	4,492 cattle 1,104 sheep	5,596	5,022 cattle 208 sheep	5,230
Commonwealth Countries (including Northern Ireland and Canada)	104 cattle 134 sheep	238	230 cattle 57 sheep	287	519 cattle 129 sheep	648
Europe (other than Irish Republic)	1,302 cattle 1,750 sheep	3,052	1,395 cattle 814 sheep	2,209	789 cattle 509 sheep	1,298
Other countries (including U.S.A.)	484 cattle 484 sheep	968	1,216 cattle 566 sheep	1,782	1,397 cattle 694 sheep	2,091

195. Semen exports would probably be affected by vaccination in the same way as livestock exports. The present export trade in semen is small but it is growing; in the twelve months from 1st August, 1967 to 31st July, 1968 16,560 doses (worth about £19,500) were exported. During the year from 1st August, 1968 exports are expected to increase to about 25,000 doses (worth £33,300). The estimates for 1969/1970 are 56,000 doses (worth about £100,000) and for 1970/1971, 63,500 doses (worth about £120,000). It seems that vaccination would present difficulties for exporters of both livestock and semen, but if the demand is strong enough they could be overcome with the imposition of quarantine restrictions and testing.

Ring Vaccination following an Outbreak of Foot-and-Mouth Disease

196. Ring vaccination is directed against the spread of foot-and-mouth disease and to attain the best results should be introduced immediately an outbreak occurs. Difficulties can arise if it is applied at a late stage in the development of an epidemic (see paragraphs 206 and 208). One of the ways in which ring vaccination might be applied immediately an outbreak occurs in Great Britain is described as follows:

(i) At every initial outbreak, a vaccination area would be declared. The shape and size of the area would depend on the circumstances of the outbreak.

(ii) Additional vaccination areas, extensions or amalgamations would follow depending on the pattern of subsequent outbreaks.

(iii) Within each vaccination area, all cattle and sheep over three months and all pigs over two months of age would be vaccinated.

(iv) Vaccination would be started both at the centre and at the periphery. All stock would be inspected by a veterinarian prior to vaccination; this would be particularly important within two miles of the infected premises, and it would replace the present patrol procedure.

(v) It is estimated that the type of virus would be identified within two hours of suitable material for diagnosis reaching the Animal Virus Research Institute. Sub-typing may require from twelve hours to three days.

(vi) If the sub-type cannot be identified rapidly, a polyvalent vaccine containing the expected sub-types could be used for vaccination.

(vii) Stocks of suitable vaccine prepared from the predicted types or sub-types would have to be maintained.

(viii) Immediately an outbreak was confirmed, vaccine sufficient for at least two days vaccination would be despatched to the area. Thus vaccination could commence on neighbouring farms on the day following confirmation. Further supplies, and a reserve to accommodate extensions, would be put into local cold stores.

(ix) Vaccination of all stock in the first area would be completed within five to seven days of confirmation of the disease and in additional areas within a further four to six days. The speed with which vaccination could be completed would depend upon the number of veterinarians and lay assistants working under veterinary direction that could be assembled rapidly. It is likely that each vaccinator could inoculate between 500 and 600 animals each day. Single outbreaks could easily be dealt with but a rapid build-up of new outbreaks, requiring additional staff, could present difficulties.

197. The slaughter policy would still be implemented on any farm where foot-and-mouth disease was diagnosed, whether the stock were vaccinated or unvaccinated. Cleansing and disinfection of infected premises would be carried out. Stock would be inspected in a two mile ring around the outbreak to discover infected animals not showing obvious clinical signs, a condition which might occur as a result of partial protection from vaccination. Those premises near the centre would be inspected each day at first and later at three-or four-day intervals. Those towards the perimeter would be inspected at five-to seven-day intervals.

198. It is not easy to estimate exactly the extent to which secondary spread would be limited. A number of factors are involved: the prevailing weather conditions; the speed at which the ring vaccination is begun and completed; the extent to which markets are affected; the amount of the virus present at the initial outbreak, and the rate at which spread of the virus takes place; and the time it takes for immunity to develop following a primary vaccination. The Ministry of Agriculture tried to estimate what effect a scheme of ring vaccination would have had on past outbreaks. They thought that in a large number of outbreaks, ring vaccination would have had no effect on the spread of the disease because they were entirely controlled by slaughter. In some major outbreaks, however, ring vaccination would have limited considerably the extent of secondary spread; for example in the 1967/1968 epidemic, if ring vaccination had begun early, the number of outbreaks might have been reduced by about one half. This, however, depends on certain assumptions which the Ministry of Agriculture made. Although ring vaccination implies a circle, and the word "ring" has been used in this context, the shape and size of the area would, we think, be highly important (see paragraph 196(i)). We envisage that a more scientific method of defining the vaccination area would be essential. The circumstances that would be relevant would include wind and weather, stocking densities and movements. To assist in determining their importance we think that it would be advisable to rely on the advice of a team of experts comprising meteorologists, epidemiologists and veterinarians (see paragraph 215).

199. We have considered the probable cost of ring vaccination as an adjunct to slaughter. If outbreaks in the future are assumed to be on the same scale as in the past, we think that the costs of vaccine and vaccination would be largely offset by a reduction in the number of secondary outbreaks that would be brought about, with consequential savings in compensation for slaughtered stock. We do not think that the annual cost of ring vaccination and slaughter would on average over a period of years greatly exceed the cost of a slaughter policy alone. However, on the assumption that there are no outbreaks at all, there would still be an annual maintenance cost of rather less than £1 million; a ring vaccination scheme depends on the immediate availability of vaccine and it would be necessary to carry a substantial stock which would have to be renewed periodically when its useful life—about 12 to 18 months—was exhausted. The estimate of cost for a stock of vaccine is based on a stock of 10 million cattle doses at 1/6d. per dose, together with an allowance for other storage expenses.

200. The practical difficulties of ring vaccination are considerable. One of the main difficulties is the mustering of large numbers of animals at short

notice which could cause them considerable stress particularly at certain times of the year, such as at lambing and Spring calving times. In addition fog or snow could create hazards for both men and stock; and there would always be difficulty in bringing in all the stock. Another danger would be the removal of animals from the relatively infection-free hills and outlying areas to farm steadings where they would be more likely to be exposed to the disease.

201. It would be necessary, after vaccination, to inspect stock within a two-mile radius of the outbreak. Occasionally, in the event of a prolonged outbreak it might even be necessary to re-vaccinate all stock later.

202. There would also be a call on the relatively small labour force available on farms. Furthermore farmers would be reluctant to leave their farms to assist their neighbours if this entailed any risk of introducing the disease to their own premises. They might also be reluctant to allow vaccination teams on their farms for fear of introducing the disease.

203. Ring vaccination has been successful in Denmark and has not led to the disruption of the general practices of marketing and the movement of livestock, but their experience in this respect is not strictly applicable in this country. It is likely that the small amount of movement of cattle in Denmark has contributed to the success of ring vaccination in that country; in Great Britain, on the other hand, there is a much larger movement of animals to markets. Denmark has only six major livestock markets compared with over 1,000 livestock markets and fairs in Great Britain. Another major difference is that there is much less exchange of animals between herds in Denmark than there is here. In the dairy industry in this country there is considerable movement of animals. Each year some 300,000 cows are sold in milk or in calf together with 400,000 other cows, 1,250,000 calves and 100,000 dairy store cattle; there are also private transactions which involve the movement of animals from farm to farm. In addition to dairy stock movements there are large movements of beef cattle, sheep and pigs. For instance young animals are often reared in one district and moved to another for fattening.

204. Ring vaccination would make the problem of restocking after an outbreak considerably greater than at present. It is unlikely that there would be sufficient quantities of stock for purchase from within the ring vaccination area and such as were available might be at a high premium. Clearly it would be necessary to vaccinate animals that were moving into the ring for some time after the outbreak.

205. There are also problems in moving animals from inside the vaccinated area to farms outside. The Danish Government permits such movement after 30 days following an outbreak. In March, 1968 the European Commission for the Control of Foot-and-Mouth Disease considered this problem in respect of exports of live animals from areas of barrier vaccination and concluded that it would be wise to allow three months to elapse after vaccination before moving animals for export from a vaccinated area. Nevertheless there would be reluctance among farmers outside the vaccinated area to accept cattle from within a vaccinated ring.

206. We have already said that for ring vaccination to be successful it should be carried out immediately an outbreak occurs. It was suggested to us that vaccination might be delayed to allow some assessment to be made of the possible development of an outbreak. This would be entirely contrary to the whole

object of the operation, and we therefore consider that ring vaccination, if introduced, should be carried out as soon as an outbreak occurs. There may however be occasional instances where livestock, because of their isolated position, would present no significant risk. In such cases the mandatory provisions might be waived.

207. If, as would happen in the event of a large number of scattered outbreaks, large areas of the country and large numbers, say fifty per cent of animals were involved in ring vaccination, then general prophylactic vaccination would probably become inevitable.

Emergency Ring Vaccination

208. We think that the adoption of emergency ring vaccination as a policy after an epidemic had become established would contribute little towards control and would probably lead to a policy of general vaccination (see paragraphs 206 and 207). In the event of ring vaccination becoming extensive it would be tantamount to barrier vaccination.

Barrier Vaccination

209. It is unlikely that barrier vaccination would have much application in this country, but it might be necessary should an outbreak get out of control.

Prophylactic Area Vaccination

210. It has been suggested to us that prophylactic vaccination, limited to areas of high cattle density, might be used to protect cattle in parts of the country where primary outbreaks were likely to lead to epidemics. The selection of areas on the basis of a high risk of spread of foot-and-mouth disease would present difficulties. The west-Midlands area, which was affected in the 1967/1968 outbreak, might be considered a candidate for selection, and elsewhere density of stocking and intensive dairying might be used as the criteria. Somerset, part of Devon, possibly part of Wiltshire and part of Gloucestershire might then have to be considered. There is an area of dense stocking in Cumberland, but it has never been involved in a major crisis and in such a case the criteria might be waived. On the other hand, there are many areas for which a case might be made out on the basis of past difficulties, for example the Forest of Dean in Gloucestershire (see paragraph 61) and Dumfriesshire (see paragraph 134). There is always a problem in relation to possible infection of animals in unfenced areas where, for example, hill sheep populations could be at risk (see paragraph 57). There have been occasions when east and south coast counties suffered a high number of primary outbreaks which were associated with infection from the Continent. But the position in Europe has now improved to the extent that these southern and eastern coastal belts need no longer be regarded as areas of particular risk in comparison with other parts of Great Britain (see paragraph 139).

211. We see considerable difficulties in implementing a scheme of this nature. When the incidence of primary outbreaks of foot-and-mouth disease in other areas of the country is examined no very clear pattern emerges; the distribution appears to have been random. It would be extremely difficult, therefore, to select areas for vaccination on any reasonable basis and we can see no benefit in applying this method of control.

(*d*) Other Treatments and Remedies

212. We have received many other recommendations for preventing foot-and-mouth disease and controlling epidemics; these have covered homoeopathy,

dietetics and other practices. We consider there is no scientific evidence that at this stage they might have a part to play in controlling the disease in Great Britain. Research work on chemo-therapeutic substances with anti-viral properties, particularly in relation to smallpox, is promising, and such work will undoubtedly be extended to foot-and-mouth disease. At one time serum therapy, which produces a passive immunity, was practised in controlling the disease but the development of vaccine, which produces an active immunity, has made this process obsolete.

(*e*) Research

213. Before 1964 the work of the Animal Virus Research Institute at Pirbright was confined almost entirely to foot-and-mouth disease research; since then its main effort has continued to be concentrated on the disease but work has also been carried out on other viral diseases of animals. The buildings at Pirbright are well designed and equipped to prevent the escape of viruses and security measures are rigidly enforced. The Institute has an independent Governing Body, and for the purpose of scientific policy, administration and finance it is under the aegis of the Agricultural Research Council. The work of the Institute has been directed towards basic research, vaccine research and epidemiological studies. Before the 1967/1968 epidemic there was little opportunity for studying epidemiology in this country and it has been recognised that one of the most useful methods of reducing the risk of introducing the disease into Great Britain is in improving the disease position abroad. To this end the Institute has given high priority to the development of vaccines and the promotion of vaccination programmes in overseas countries. It has been designated by the Food and Agriculture Organisation of the United Nations as the World Reference Centre for the typing of foot-and-mouth disease virus. We hope that the present programmes of the Institute will be continued, and would like to see an expansion, to include epidemiological studies in foot-and-mouth disease.

214. The Ministry of Agriculture has a Department of Virology at its Central Veterinary Laboratory at Weybridge which is not at present involved in the study of foot-and-mouth disease. We would like to see the Weybridge laboratory staff's interest extended to include work on foot-and-mouth disease in association with the work at the Animal Virus Research Institute. We consider that work with live foot-and-mouth disease virus should be restricted to the Institute's premises. It is also desirable that some members of the Ministry's field veterinary staff whose present duties include foot-and-mouth disease control in the field should be given training in epidemiology with particular reference to this disease.

215. Epidemiological teams, comprising personnel from the Animal Virus Research Institute, the Ministry of Agriculture's Veterinary Laboratory Services and Field Service, and supported by other appropriate experts such as meteorologists, aero-biologists and statisticians, should be formed. These teams would have two main functions. In an outbreak they would collect information by studying the outbreak from the start, predicting its probable development and so provide information which would help in formulating measures to control it. They would also collect data for the purpose of future epidemiological studies. The teams should gain experience in working together before outbreaks occur so that they would be fully prepared when their services were required.

CHAPTER VIII

RECOMMENDED POLICY

216. Our recommendations for reducing the risks of the introduction of foot-and-mouth disease, and for controlling its spread, are based on a consideration of the various policies including slaughter, import control and vaccination described in Chapter VII, and on our judgment as to which of these are appropriate to Great Britain.

217. We have shown in earlier chapters that there are substantial gaps in our scientific knowledge of foot-and-mouth disease, particularly in relation to some aspects of epidemiology. It is not possible therefore to make recommendations regarding prevention and control policies purely on scientific grounds.

218. We have attempted to assess the gradient of risks of the introduction of foot-and-mouth disease in meat and meat products. The degrees of risk will depend on Government policy. The risks would be greatest if there were unlimited importation of meat and meat products from all countries irrespective of their foot-and-mouth disease status, and least if meat were imported only from foot-and-mouth disease-free countries such as Australia and New Zealand. Between these extremes there are varying degrees of risk depending on what restrictions are applied to imports of meat and meat products and offal, and on whether such imports have their origin in countries where the disease is sporadic and the risks are less, or in countries where the disease is endemic and the risks are greater. We have pointed out that the major risks derive from the persistence of foot-and-mouth disease virus in bones, offal and lymph glands, and we think that if a policy is adopted which excludes these dangerous components, the reduction of risk would be almost equivalent to that which would be achieved by a complete ban on meat imports.

219. Slaughter, which is the best method of eradicating the disease, is essential whatever policy is adopted, but the adoption of a policy which relies on the slaughter policy alone should, in our view, be dependent either on a complete ban on imports, or at least on the exclusion of the dangerous components of meat, from countries or areas of countries where foot-and-mouth disease is endemic. If these dangerous components are not excluded we think it essential that some form of vaccination should be introduced.

220. General vaccination gives a large measure of protection but this advantage has to be balanced against the disadvantages attaching to the disturbance of normal farming practice, the diversion of veterinary manpower and the very considerable cost (see paragraphs 177 to 195).

221. Ring vaccination would not limit the number of primary outbreaks but it could limit spread. Although it has considerable disadvantages (see paragraphs 200 to 205), we think that in certain conditions ring vaccination could be a useful adjunct to slaughter.

222.—I. We **recommend** that the slaughter policy, which we consider to be the best method of eradicating foot-and-mouth disease when it occurs in Great

Britain, should be continued. This policy by itself should only be adopted if the conditions of meat import policy are such as to reduce substantially the risks of primary outbreaks occurring. If such conditions of meat import policy are not put in force we would recommend that the slaughter policy should be reinforced by a ring vaccination scheme (see paragraphs 173 to 175 and 196 to 206).

II. The conditions of meat import policy which in our view are necessary to enable the slaughter policy by itself to be continued and which we **recommend** are:

(*a*)

(i) The ban on imports of mutton, lamb and pigmeat from countries or areas of countries where foot-and-mouth disease is endemic should continue (see paragraphs 150 and 152).

(ii) Imports of mutton and lamb offal and pig offal from countries or from areas of countries where foot-and-mouth disease is endemic should be limited to offal processed in such a manner as to destroy foot-and-mouth disease virus (see paragraphs 14 to 17, 144, 164 and 165).

(*b*) Because there is a high risk of introducing foot-and-mouth disease into Great Britain by importing carcase beef and beef offal from countries or from areas of countries where foot-and-mouth disease is endemic, on strictly animal health grounds there should be a complete ban on all such imports (see paragraphs 14 to 17 and 144 to 170).

(*c*) Alternatively if for social, political or commercial reasons the recommendation in (*b*) is not accepted, imports of carcase beef and beef offal from countries or from areas of countries where foot-and-mouth disease is endemic should be limited to—

(i) boned-out beef (see paragraphs 14 to 17, 165 and 166); and

(ii) beef offal processed in such a manner as to destroy foot-and-mouth disease virus (see paragraphs 14 to 17 and 164 to 165).

III. We **recommend** that:

(*a*) Our veterinary staff in South American countries should be strengthened in order that standards of public health inspection acceptable to the British Government can be ensured and so render the retention of lymph glands in boned-out cuts of meat unnecessary, and in order to assist the implementation of the Bledisloe arrangements (see paragraph 168).

(*b*) Because some countries in which foot-and-mouth disease is endemic have well-defined areas which for geographical or other reasons are free of the disease and which could be accepted as safe sources for imports of meat, provision should be made to permit imports of meat, under suitable safeguards, from such areas (see paragraph 49).

IV. We **recommend** that contingency plans for the application of ring vaccination should be kept in constant readiness. They could be put into operation should our recommendations in II not be successful in limiting the number of outbreaks (see paragraphs 196 to 206 and 221).

V. We **recommend** that the importation of meat and meat products from all sources be subject to revocable conditional licences (see paragraph 146).

VI. We **recommend** that adequate facilities for cleansing and disinfection of vehicles and persons engaged in the transport of livestock should be a legal requirement at appropriate points of entry into Great Britain (see paragraph 141).

VII. We **recommend** an expansion of research work on foot-and-mouth disease, particularly in epidemiology, on the lines suggested in paragraphs 213 to 214, and the use of epidemiological teams in the field (see paragraphs 198 and 215).

223. A dissenting note, by Anthony Cripps, Q.C., follows.

Signed

NORTHUMBERLAND (Chairman)
ANTHONY CRIPPS
DAVID G. EVANS
C. HENRY PLUMB
ERIC L. THOMAS
EDWARD THOMPSON
DAVID WALKER
WILLIAM L. WEIPERS

JOHN N. JOTCHAM (Secretary)
MELBA D. WHITE (Assistant Secretary)

7th March, 1969.

DISSENTING NOTE

by Anthony Cripps, Q.C.

1. The extent of my dissent from my Colleagues is that I would delete the second and third sentences of Recommendation I; substitute " We recommend " for the first three lines of Recommendation II; and substitute for the second sentence of Recommendation IV " They should be put into operation whenever an outbreak occurs ". In short, the immediate application of ring vaccination to any outbreak which occurs seems to me essential. That I am unable to agree with them is a matter of personal regret since I have the highest admiration for the completely disinterested and impartial approach and final judgments of all those eminent and discerning men in so many different walks of life with whom I have had the privilege and pleasure of studying the various problems over the last year.

2. There are two basic reasons for this dissent. First, I do not consider that any diminution in the risk of introduction of the virus to be anticipated from any meat import policy in relation to countries where the disease is endemic and from any improvements in the disease situation abroad is at present sufficiently certain to reduce the risk of introduction—from anywhere in the world—to, or almost to vanishing point. Secondly, we are now at a stage at which it must be a matter of no more than estimate to what extent that risk will be reduced by a hitherto untried meat import policy while in about six years time we shall know **as a matter of fact** how far any such meat import policy has or has not been successful in reducing that risk.

3. Every diminution in the risk of introduction of virus into the country reduces the number of occasions upon which the risk of the disease spreading can arise. If the risk of introduction is reduced to, or nearly to, vanishing point, then the risk of any spread is correspondingly reduced either to vanishing point or to the point at which the risk of spread will arise so very rarely that it may be reasonable to take less stringent precautions against spread than would otherwise be considered necessary. The vital question upon the answer to which should depend the policy to adopt in future seems to me therefore to be whether or not the anticipated diminution in the risk of introduction of the virus into this country will reduce that risk to, or nearly to,vanishing point.

4. In considering the extent to which diminution in the risk of introduction of the virus into the country is likely, one possible if not particularly convincing approach is to start from whatever evidence is available as to past introductions and their origins, then to make allowances both for improvements, recent or anticipated, in conditions generally and for improvements to be anticipated from any new meat import policy, and finally to try and arrive at some estimate of the extent to which the risk of introduction is likely to be reduced. The evidence as to the origins of past introductions is sparse and consists of attributions to probable origins of primary outbreaks made by the Ministry over the period 1954 to 1967, excluding the 1967/1968 Oswestry outbreak. All these attributions are not necessarily correct; many have had to be made on much less evidence than was desired: but the general picture presented by them is probably not misleading. From Table X in paragraph 148 these attributions show 74

out of 179 (41%) only attributed positively to endemic countries. Certainly some of the remainder would have been attributable to endemic countries if more facts had been known, but I see no reason to think that this addition would be any particular proportion, because there is so much uncertainty underlying these attributions. This leaves 59% attributable to non-endemic countries or about which we really know very little. This percentage of origins which are either "obscure" or not positively connected with any endemic country is disturbing. Another approach is to forget all about past attributions and to form a judgment based on a general appreciation of all the evidence we have received over the past year. Here again the impossibility of arriving at a view purely on scientific grounds, and the substantial gaps in our scientific knowledge of the disease, mentioned in paragraph 217 emphasise that while there is now a wide area of what is known there is also a wide area covered by the element of the unknown. While a suitable meat import policy would substantially reduce risk of introduction **from endemic countries** (or possibly eliminate it), it would not have the slightest effect on risk arising otherwise than from meat or arising from non-endemic countries. I can find no evidence to justify the inference that any such policy would necessarily reduce that risk of introduction **from everywhere** to or almost to vanishing point, even if one makes to the best of one's ability allowances for improvement in conditions on the Continent since 1954 and to be anticipated in the coming years.

5. When virus succeeds in getting into this country one small introduction of the virus could produce another epidemic, and all our witnesses who gave any view on this matter agreed that it could not be said that another epidemic of Oswestry proportions might not occur again **at any time.** This is the most vital factor in showing the need for ring vaccination. The statistics of numbers of outbreaks (primary and secondary) over the years support the view that an epidemic is only to be expected something like once in about 20 years; but there is no reason to think that this fatal year will in future occur at regular or even moderately regular intervals. It may next occur as well in 1970 or 1971 as in 1987 or 1988. Some reduction in the risk of spread is to be anticipated from improvement in the administrative arrangements connected with the slaughter policy, but those arrangements (with which we shall be dealing in Part II of our Report) were not so inadequate that this improvement can be expected to make more than a marginal difference. Whatever the meat import policy in relation to endemic countries may be, a definite risk of one small introduction from somewhere and of a consequent epidemic in any one year will remain. If possible therefore some other means of reducing this risk seems to me to need to be found.

6. Such a means exists in the modern weapon of vaccination, now more efficient and less costly than at the time of the Gowers Report, (see paragraph 191). Though this country is one in which the disease is not endemic we can no longer consider it as being as geographically isolated as in 1954 with the immensely increased passenger and vehicular traffic to and from Europe, the increased air passenger traffic everywhere, and the increased knowledge of the extent to which the disease may be wind-borne. We are less isolated in some ways than the larger of those countries which have been free of the disease for long periods, such as New Zealand, Australia, and the countries of North America, and possibly than Ireland, Iceland and Norway. But the important characteristic in which we differ from all those countries is that, for whatever cause, we have not

been free of the disease for any period longer than $2\frac{3}{4}$ years (and that only once) since 1954, while all those countries have been free for the whole of that period and longer. Had we been (or if we should in future be) free for some substantial length of time, such as six years, that would be a significant factor in relation to future policy and one to which considerable weight ought to be given, because it would be a matter of fact as opposed to one of theory or estimate. Those countries do not import meat from endemic countries, and this **may** be the reason for their freedom from the disease; it is not easy to suggest any other: but whether it is the reason or not we shall be better able to judge by reference to fact after we have adopted such a meat import policy as we recommend for six years than we are able to do at the present time by reference to theory or estimate only.

7. General prophylactic vaccination may appear the sensible and scientifically tidy solution. Its advantages and disadvantages are discussed in paragraphs 177 to 195. Costs in two countries in which this is the policy work out at 4d. and 8d. a dose respectively, and little needs to be added for administrative expenses since in one of them vaccination was being successfully carried out by farm hands without any veterinary assistance though with the knowledge that a veterinary surgeon (who had to be notified in advance of any vaccination) might make a " spot check " on any occasion. This should be able to be done in this country. After the initial year or so it is difficult to see why general prophylactic vaccination need cost more than a few shillings per beast per year and this is well within the means of any farmer and would probably represent good value for money. But inspection (as opposed to vaccination) must always require veterinary expertise. Additional manpower consumed by farm workers and additional veterinary time should not be great after the initial arrangements and basic training for farm hands have been effected. Carrier animals may create a risk in theory and it cannot be shown that there is no such risk, but the absence of any known case where this risk had produced disease after deliberate experimental attempts to do so, indicates that, until anything further is known to substantiate this risk as more than infrequent and unusual, it would be wrong to give much weight to it. The practical problems arising out of application of such a policy will no doubt continue to be kept under review; in a year or two improved vaccines effective in pigs and with a longer shelf life will probably become available. But general prophylactic vaccination has usually only been introduced as a second stage following after some more limited form of vaccination, and there is of course a possibility that over the next 20 years the number of outbreaks in this country may sufficiently decline to make such a policy unnecessary: for these reasons only I would not recommend general prophylactic vaccination at this time.

8. Ring vaccination in the event of an outbreak is the policy which my Colleagues consider could in certain conditions be a useful adjunct to slaughter (see paragraph 221) and would recommend as a reinforcement of the slaughter policy in certain circumstances. Though ring vaccination in the event of an outbreak may be almost worthless for potentially insignificant outbreaks, it will be of some, and may be of immense, value for potentially epidemic outbreaks. In the latter cases, the evidence indicates that, in certain conditions and on certain assumptions, about half the total of farms only would have been affected after a potentially epidemic outbreak has occurred if ring vaccination in the event of an outbreak were applied to the outbreak as immediately as possible;

these conditions and assumptions of course involve much that is uncertain, but were such as to indicate that about half may well be a substantial underestimate of what would have been unaffected. The question of how much ring vaccination would have contained the Oswestry outbreak is of course speculative, but a reasonable inference is that of the 2346 farms at least 1170 would probably have been saved by ring vaccination. This would have been worth doing. This view depends on knowledge gained since that outbreak, but in the light of present knowledge it seems to me to follow that the policy actually applied to the Oswestry outbreak was the wrong policy for that outbreak. If general prophylactic vaccination followed ring vaccination that would be no disadvantage, but would simply show that such vaccination had unfortunately become necessary and therefore desirable.

9. Ring vaccination in the event of an outbreak combined with slaughter is open to the criticism that it is from a tidy scientific point of view a half-way house between the present policy of slaughter only and the complete policy of general prophylactic vaccination with slaughter. But the advantages of that policy, compromise as it may be, in terms of probable practical results will be seen far to outweigh any disadvantages. If one tries to look into the future realistically, the coming years can be divided into three categories:

(1) those in which no outbreaks at all occur in this country, in which there will be no vaccination because none will be needed, but some cost waste on control storage and renewal of vaccine;

(2) those in which only potentially insignificant outbreaks occur, when there will be a little vaccination but not much, rather less cost waste on control storage and renewal, possibly not a very worthwhile result but useful experience will be gained in those years from small practical applications of the policy; and

(3) those in which potentially epidemic outbreaks occur, in which worthwhile results will be achieved, and the first educative and preparatory steps will be taken towards general prophylactic vaccination, should it unfortunately prove to be necessary at a later stage.

No one can possibly foresee into which category any one year will fall and there is no evidence at present to justify the assumption that any one year will not fall into the third category. It is therefore advisable to take precautions against such a possibility now rather than to wait until a later date by which the fatal year may already have occurred again.

10. The great objection to not combining a general policy of ring vaccination in the event of an outbreak with slaughter is that this involves taking the risk that one small introduction of the virus into this country may produce an epidemic of Oswestry proportions in any year. That risk appears to me entirely unacceptable at the present time when we have not been free of the disease for more than $2\frac{3}{4}$ years (and that only once) in modern times. If however at some future date the country were to have been entirely free of the disease for some substantial length of time, such as 6 years, then I would consider that as important evidence that a less dangerous stage had in fact been reached, and would then—but not before—make similar recommendations to those which my Colleagues do now. For the present, therefore, I recommend the immediate application of ring vaccination to any outbreak which may occur.

Signed ANTHONY CRIPPS
7th March, 1969

EVIDENCE RECEIVED

The following bodies or individuals have expressed views to us orally and/or in writing. Those who gave written and oral evidence are marked with an asterisk.

Aberdeen County Council

Aberdeen and District Milk Marketing Board

*Agricultural Research Council—

Represented by Sir Gordon Cox, K.B.E., T.D., D.Sc., F.Inst.P., F.R.I.C., F.R.S.

Agricultural Research Council Meat Research Institute

*Agricultural Research Council. Institute for Research on Animal Diseases—

Represented by Dr. W. M. Henderson, D.Sc., M.R.C.V.S.

Anglers' Co-operative Association

Animal Health Trust

*Animal Virus Research Institute—

Represented by Dr. J. B. Brooksby, D.Sc., Ph.D., M.R.C.V.S., F.R.S.E.
Dr. F. Brown, B.Sc., M.Sc., Ph.D.
Mr. R. Burrows, B.Sc., M.R.C.V.S.
Mr. J. Davie, B.Sc., M.R.C.V.S.
Dr. G. N. Mowat, Ph.D., M.R.C.V.S.
Dr. R. F. Sellers, M.A., B.Sc., Ph.D., M.R.C.V.S.
Mr. H. H. Skinner, F.R.C.V.S.

*Association of the British Pharmaceutical Industry—

Represented by Dr. P. B. Stones, M.R.C.S., L.R.C.P., M.B., B.S., M.Ph., F.C.Path.

Association of Chief Police Officers of England and Wales

Association of County Councils in Scotland

Association of Municipal Corporations

Association of River Authorities

Bank of London and South America Ltd.

Bedford County Council

Belted Galloway Cattle Society

*Birds Eye Foods Ltd.—

Represented by Mr. A. E. Hardwick
Mr. R. Symons, M.A.

Board of Inland Revenue

*British Agricultural Export Council—

Represented by The Hon. F. N. W. Cornwallis, O.B.E.
Mr. A. Jenkins
Mr. I. R. Wylie

*British Association of Meat Wholesalers Ltd.—
Represented by Mr. E. W. P. Rimer

British Bacon Curers Federation

British Broadcasting Corporation

*British Cattle Breeders' Club—
Represented by Mr. P. Dixon-Smith, N.D.A.
Mr. D. W. Fattorini

British Cycling Federation

British Field Sports Society

British Friesian Cattle Society

*British Homoeopathic Association—
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Mr. G. Macleod, D.V.S.M., M.R.C.V.S.
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Miss E. Walker

British Insurance Association

*British Livestock Exports Ltd.—
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British Railways Board

British Semen Export Ltd.

British Waterworks Association

*British Veterinary Association—
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Miss W. M. Brancker, O.B.E., M.R.C.V.S.
Mr. P. B. Capstick, B.V.M.S., M.R.C.V.S.
Mr. J. A. Pasfield, O.B.E., M.R.C.V.S.

Compound Animal Feeding Stuffs Manufacturers National Association Ltd.

Central Association of Agricultural Valuers

Chandler, Hargreaves, Whittal & Co. Ltd.

Chartered Land Agents Society

*Cheshire Agricultural Society—
Represented by Mr. F. Hughes

*Cheshire County Council—
Represented by Mr. C. W. Hobson
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Chief Constables (Scotland) Association

Counties of Cities Association

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*Country Landowners Association—
Represented by Mr. N. E. Strutt, T.D., D.L.

Crofters Commission

Dartmoor Livestock Protection Society

Deneside School Youth Association

*Department of Agriculture and Fisheries, Dublin—
Represented by Mr. M. J. Barry
Mr. H. G. Foster
Mr. M. G. Hynes, M.R.C.V.S.

Department of Education and Science
(Combined with Central Council of Physical Recreation)

Devon Cattle Breeders' Society

Devon County Council

English Cross-Country Union

Fatstock Marketing Corporation

*Federation of Wholesale Fresh Meat Traders of Great Britain and Ireland—
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Mr. H. E. Bywater, M.R.C.V.S.
Mr. A. W. Clift
Mr. J. F. Moore, F.C.A.

*Farmer and Stockbreeder—
Represented by Mr. P. Bell, B.A.

*Farmers' Union of Wales—
Represented by Mr. R. P. Davies
Mr. R. O. Hughes
Mr. W. H. Jones
Mr. G. Pugh

*Farmers' Weekly—
Represented by Mr. M. Leyburn, B.Sc.
Mr. M. R. Williams, B.Sc.

Flintshire County Council

*Food and Agriculture Organisation of the United Nations—
Represented by Dr. P. R. Ellis, M.P.H., B.Sc., M.R.C.V.S.

*Foot-and-Mouth Disease Sub-Committee of Conservative Party's Agricultural Committee—
Represented by Mr. J. M. Temple, J.P., M.P.

Gaskell Bros. Ltd.

*George Wimpey & Co. Ltd.—
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Horserace Betting Levy Board

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Mr. W. M. Pooley, O.B.E.

*Institution of Professional Civil Servants—

Represented by Dr. P. Dawson, B.Sc., Ph.D., B.V.M.S., M.R.C.V.S.
Mr. N. MacGregor-Burns, M.R.C.V.S.
Mr. W. H. Palmer
Mr. A. Taylor, M.R.C.V.S.

Jockey Club

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Joint English and Scottish Livestock Auctioneers Consultative Committee

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Lloyds

Master of Foxhounds Association

*Mersey and Weaver River Authority—

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*Meteorological Office—

Represented by Mr. G. W. Hurst, B.Sc., A.R.C.S., B.I.C.
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Mr. P. B. Wright, B.Sc.

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*Microbiological Research Establishment—

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*Midland Marts Ltd.—

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*Milk Marketing Board for England and Wales—

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Mr. P. Jackson, M.A.
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Sir Richard Trehane, B.Sc.

Milk Marketing Board for Northern Ireland

*Ministry of Agriculture, Fisheries and Food—

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Mr. J. G. Carnochan,
Mr. D. J. Drummond, M.R.C.V.S.
Mr. R. H. Ewart, M.R.C.V.S.
Mr. I. A. Graham, M.R.C.V.S.
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*Ministry of Agriculture for Northern Ireland—

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Ministry of Defence

*G. O. C. Western Command—

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Royal Armament Research and Development Establishment

Ministry of Housing and Local Government

Ministry of Technology

(1) Laboratory of the Government Chemist
(2) Water Pollution Research Laboratory

Morville and District Agricultural Club, Shropshire

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National Association of Corn and Agricultural Merchants Ltd.

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Mr. F. D. Johnson, B.E.M., M.Inst.M.
Mr. J. Partington, M.Inst.M.
Mr. T. Tasker, M.Inst.M.

*National Cattle Breeders Association—

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Mr. C. H. R. Reeves, D.L.
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*National Farmers' Unions of England and Wales, and Scotland—

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*National Farmers Union (Staffordshire County Branch)—

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*National Farmers Union (Wales)—

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National Hunt Committee

*National Sheep Breeders Association—

Represented by Mr. R. E. Dowse, F.R.I.C.S., F.L.A.S.

National Stud

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Office of High Commissioner for Canada

Peak Park Planning Board

Pig Industry Development Authority

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*Public Health Laboratory Service—

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*Royal Highland and Agricultural Society of Scotland—

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Mr. J. K. M. Oliver
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Mr. W. Young, C.B.E.

Royal Institution of Chartered Surveyors

Royal Society for the Prevention of Cruelty to Animals

*Royal Veterinary College—

Represented by Sir John Ritchie, C.B., B.Sc., D.V.Sc., LL.D., F.R.C.V.S., D.V.S.M., F.R.S.E.

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The Hon. Neville Hill-Trevor

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*Sausage and Meat Pie Manufacturers' Association—

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Mr. R. Brazen, A.C.I.S.
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Scottish Pig Producers' Federation

Scottish Milk Marketing Board

Soil Association

*South American Freight Committee—

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Mr. A. G. Gordon, B.A.
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*West Mercia Constabulary—

Represented by Chief Superintendent A. Nichol
Chief Constable Willison

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Youth Hostels Association of England and Wales

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Mr. W. O. Wade
Mr. T. G. W. Wiles
*Dr. A. J. Wilsdon, B.Sc., Ph.D., M.R.C.V.S.
Mr. G. A. Wright
Lt. Col. Sir Watkin Williams-Wynn, B.V., J.P.

Foreign Countries visited by the Committee, and Persons who gave Evidence to Them.

Europe

Denmark	Mr. S. Anderson Mr. V. Bugge Mr. V. Hornslet Dr. E. Michelsen Dr. C. Werdelin
Federal Republic of Germany	Dr. W. Eckerskorn Dr. Grissler Herr Rojahn
France	Mr. A. Cortez Mr. L. Dhennen Dr. E. Matthieu Mr. J. Santamaria
The Netherlands	Dr. J. G. van Bekkum H. A. Van den Berg Dr. K. G. Robijns Mr. W. Wagenvoort Dr. J. Vervoon

South America

Argentina	Sr. A. Reichart—Under Secretary for Agriculture and Livestock Dr. Jorge Borsella, Director General of Animal Health and a team of officials from the Argentine Ministry of Agriculture, Animal Health Service, and S.E.L.S.A. (Animal Health Field Service)

[Discussions were also held with the Director and Officials of the laboratories of I.N.T.A. (National Institute of Technology) and S.E.L.S.A. which the Committee visited, and with local representatives and officials of S.E.L.S.A. during visits to the estancias of Sr. Jaun Harriet, Senora Inchauspe and Sr. Eduardo Pereda. The Committee also met Dr. Lius Firpo Miró, President of the Argentine Rural Society and some of its members and members of A.A.C.R.E.A. (Argentine Association of Regional Agricultural Experimental Stations).]

Brazil	Dr. Jose Fredre de Faria, Federal Chief Veterinary Officer and a team of officials from the Federal Veterinary Service and the Brazilian Ministry of Agriculture; also Federal veterinary officials stationed in Porto Alegre (Rio Grande do Sul)
	Dr. Jose Augusto Muller, Head of the Department of Animal Health for the State of Rio Grande do Sul, and a team of officials from the Department and from the State Veterinary Service
Uruguay	Sr. Frick Davie, Minister of Agriculture
	Sr. M. Capurro, Under Secretary of Livestock and Agriculture
	Dr. de Freitas, Chief Veterinary Officer and a team of officials from the Ministry of Agriculture and the Veterinary Service
Pan American Foot-and-Mouth Disease Center, Rio de Janiero	Dr. Carlos A. Palacios, Director
	Dr. M. Fernandes
	Dr. Lambardo
United States of America	Dr. R. J. Anderson, Associate Administrator of the U.S. Agricultural Research Service and a team of officials from the Service
	Dr. J. Callis, Director of the Plum Island Animal Disease Laboratory and a team of officials
	Dr. Shahan, past Director of the Laboratory

Countries whose Governments submitted written evidence.

Argentina
Australia
Austria
Belgium
Botswana
Brazil
Canada
Ceylon
Chile
Cyprus
Czechoslovakia
Denmark
Finland
France
Federal Republic of Germany
Ghana
Greece
Italy
Kenya
Malawi
Malaysia (West)
New Zealand
Netherlands
Nigeria
Northern Ireland
Norway
Pakistan (West)
Poland
Republic of Ireland
Republic of South Africa
Singapore
Sweden
Switzerland
Tanzania
Turkey
U.S.A.
U.S.S.R.
Uruguay
Zambia

THE NATURE OF THE DISEASE

Memorandum Submitted by the Ministry of Agriculture, Fisheries and Food

The Virus and its Types

1. Foot-and-Mouth disease (FMD) is the most contagious of all animal diseases. It is caused by a filterable virus, that is to say an organism so small that it can pass through the minute pores of a filter capable of holding back ordinary bacteria. The virus of foot-and-mouth disease although too small to be seen using an ordinary microscope is visible under the electron microscope.

2. FMD virus can be classified into differing groups or types. This classification has been based on the result of tests for immunity; animals which have recovered from infection with one type are immune to that type but remain susceptible to other types. There are seven major types classified as O, A, C, SAT.1, SAT.2, SAT.3 and Asia I. Lesser differences within these groups are classified as sub-types, e.g. O_1, A_{22}. To date more than fifty distinct sub-types have been recognised; the immunological difference between the main types is absolute but between sub-type strains within a type it is one of degree.

3. As well as the immunological difference between different sub-types other characteristics may show variation. Strains may differ in the ease with which they spread from one animal to another and the severity of the disease in different species may also vary. Some strains of virus will readily infect pigs but not necessarily cattle and vice versa. Other strains affect both species readily. The power of survival of the virus outside the animal and the degree of immunity that remains in the recovered animal are also subject to variation.

Animals Subject to the Disease

4. Cattle, pigs, sheep, wild ruminants and hedgehogs are susceptible to natural infection with foot-and-mouth disease virus. On the Continent wild deer have been implicated as a reservoir of infection but in this country they have not been shown to play any part in the spread of the disease. Hedgehogs when affected are so crippled that they are only likely to be a factor in the transmission of the disease over a small area. It has been shown however that if a hedgehog is infected shortly before hibernation the virus may lay dormant during that period and that when it awakes clinical disease may develop in about 4 days. Although this could be significant in that outbreaks might occur in an area several months after eradication was believed to have been effected, there is no evidence that this has occurred. Experimental work has shown that the coypu is susceptible to the disease but to date there is no record of natural infection in this species.

5. Naturally occurring disease has been recorded in the brown rat. Infection is thought to have entered through abrasions caused by fighting. It is not considered that infection in this species plays a significant part in the transmission of the disease although mechanically the rat could be of considerable importance in carrying the virus from one farm to another. During the 1967/1968 episode, samples from ground vermin were examined at Pirbright, and no evidence of infection was revealed. Guinea pigs, hamsters, rabbits, cats, dogs, mice and domestic poultry can be infected artificially with the virus but natural infection has not been recorded in these species.

6. Human beings have occasionally been infected with the disease but such cases are extremely uncommon bearing in mind the frequent exposure of farmers and others to the disease where infection is widespread in the livestock population.

Symptoms

7. The incubation period after natural infection is usually between three and eight days but it can be shorter or may extend to 14 days or longer.

8. The first noticeable symptoms of the disease are dullness, depressed appetite and a rise in temperature. Associated with the development of lesions in the mouth and on the feet there is an increase in the secretion of saliva, which may hang in strings from the mouth, and the sudden appearance of lameness. In cows the milk yield falls considerably.

9. Lameness in a number of animals, especially when present in more than one species—cattle and sheep or pigs, for example, should arouse the gravest suspicion. Salivation in a number of animals or even in one animal should always be looked upon with suspicion and should lead to examination of the mouth. In affected cattle salivation is very frequently accompanied by a smacking or sucking sound which is a characteristic symptom of the disease. Salivation may occur in sheep and pigs but is not nearly so noticeable in these species. It is usually sudden lameness that first attracts attention in pigs and sheep, but this symptom may escape the casual observer as the animals are so foot sore that they remain lying down. Affected cattle frequently shake their feet, as if trying to remove something from between the clays. Sheep will normally rise and move away when approached; if not it probably means that their feet are tender.

10. In goats the general condition of the animal often remains unaltered. The animal may be dull and the characteristic smacking of the lips may be seen but the appetite is often not affected. Lameness is not always evident. The milk yield is reduced and abortion of dead kids is a common feature.

11. The lesions of the disease consist of vesicles (blisters) which, in the mouth, appear on the tongue, cheeks, gums and on the dental pad. In pigs the snout is often affected. Foot lesions are usually found around the coronet, at the junction of the skin with the hoof, at the base of the supernumerary digits and on the soft tissue between the clays. They are also commonly found on the teats in females. Less commonly, they may be seen in the nostrils, around the muzzle, inside the vagina and, in pigs, on the skin of the body. The vesicles vary in size from a pin head or half a walnut or even much larger if coalescence of adjacent vesicles has occurred. They are easily broken by handling. When broken, a clear liquid flows out, the mucous membrane over the vesicle looks ragged and the undersurface has a red or raw appearance, which afterwards becomes yellow. On parts such as the dental pad, where the mucous membrane is dense, the affected mucous membrane may be thickened, and may remain attached after the vesicle is broken. On handling, this thickened portion of membrane comes away in the form of leathery-looking tissue, leaving a raw surface. The foot lesions are similar to those in the mouth, except that the covering is denser. The inflammation in the feet may lead to shedding of the clays. This happens in the later stages of the disease, but more commonly in sheep and pigs than in cattle. Even in the earlier stages the horn can frequently be seen separating around the coronet in a downward direction in sheep and pigs. When the teats are affected, damage to the udder of a permanent nature may follow. Very young calves may die from enteritis (inflammation of the bowel) without showing evidence of vesication externally.

12. In typical cases, symptoms and lesions are readily observed but when the vesicles have ruptured pain decreases and the animal may commence to eat. Occasionally the disease is manifested in a milder form, for instance, the only symptom in sheep and pigs may be lameness. Unless a close watch is kept, this may be overlooked, especially in sheep if footrot is also present in the flock, and, in pigs, if the animals are running on soft ground or in straw yards. Again, in mild cases in store cattle, especially when on good clean pasture, the period when the animals are showing typical symptoms may be so short that they may not be noticed unless the animals are caught and examined.

13. Animals usually recover from foot-and-mouth disease but the loss owing to depreciation, loss of milk, or permanent damage, is considerable. Abortion may occur and mortality may be heavy among very young animals. Many ewes and lambs may be lost if an outbreak occurs during the lambing season. Some outbreaks,

however, are more virulent than others and, in a very virulent outbreak, a considerable number of animals of any age may die.

Spread of the Disease

14. All parts of the body of an animal affected with foot-and-mouth disease are infective, in particular the virus is present in great concentration in the fluid of the vesicles and is also excreted in the saliva, milk, urine and dung.

15. Virus appears in the blood soon after infection, and all excretions including the saliva, urine, milk, faeces and semen may be infected before the animal is clinically ill and for a short period after the symptoms have disappeared. Maximum infectivity occurs during the period when the vesicles are developing, rupturing, and releasing the vesicular fluid. In the past it has been considered that convalescent animals were infective for a limited period only, except insofar as the virus might persist on the skin or hair: however, work since 1959 gives rise to the belief that some animals may carry the virus for several months after recovery from the clinical disease.

16. Experimental work at Pirbright with virus isolated from field samples during the 1967/1968 epidemic suggests that cattle and sheep may be sources of infection for periods up to five days and pigs up to ten days before clinical symptoms appear. Whether this is a phenomenon due to a characteristic of this virus remains to be proved. But in the past the slaughter policy has succeeded despite the apparent advantage held by the virus.

17. Animals usually pick up the virus by direct contact with an infected animal in byres, pastures, markets, lairages or in transport vehicles. When an animal is salivating, the threads or droplets of saliva (and such things as straw contaminated thereby) may be blown a considerable distance by the wind and thus reach other animals.

18. Indirect contact is, however, of more far-reaching importance in the spread of the disease and this is linked with the fact that the virus can survive for long periods outside the living animal. The disease may be spread by the hands, boots or clothes of milkers or other attendants. It may be carried considerable distances in farm produce whether used as feedingstuffs for animals or as packing material and it may be disseminated through a contaminated water supply. The roads, loading docks, etc., along which affected animals have passed and the wagons in which they have travelled may remain infective for some time. Ground vermin and game, rats, fowls, birds, cats, dogs, foxes and horses may act as mechanical carriers of infection. Hedgehogs and occasionally rats may become infected and could, therefore, also be direct transmitters of disease.

19. Milk from infected animals used for feeding other stock may transmit infection, as may skimmed milk or whey. Of equal importance infected milk may contaminate churns and milk lorries or storage tanks at milk depots, which may in turn contaminate subsequent consignments of milk or may contaminate " churn washings " commonly used for feeding pigs.

20. The virus is destroyed by heat, direct sunlight and certain disinfectants, but cold and darkness favour its survival. Vesicular fluid dried rapidly on glass slides at 37 °C. is often inactivated immediately, but when dried slowly at room temperature it may survive for several months. Laboratory tests have shown that under suitable conditions the virus can survive at least 14 days on wool, four weeks on cow hair, 11 weeks on boot leather, 14 weeks on rubber boots and 15 weeks on hay. Cold storage conditions in the meat trade also favour the survival of the virus. The virus is destroyed by the acidity which develops in the muscular tissues of slaughtered carcases stored at normal temperature during the development of rigor mortis (the setting of the carcase). If an infected carcase is chilled or frozen immediately after slaughter the acidity does not develop in the muscles and hence the virus may retain its infectivity for some months. Furthermore liver, kidneys, tripe, bone marrow and lymph glands do not develop acidity, and virus survival for periods up to 4—5 months have been recorded. If a susceptible animal comes in contact with any part of such contaminated material or part of an infected carcase it is likely to develop the disease.

ORIGIN OF THE 1967-68 FOOT-AND-MOUTH DISEASE EPIDEMIC

Presented to Parliament by the
Minister of Agriculture, Fisheries and Food
by Command of Her Majesty
March 1968
Cmnd. 3560

The original outbreak

1. The first case in the present epidemic was reported on 25th October, 1967, on the premises of R. N. Ellis, Bryn Farm, Nantmawr, Oswestry, Shropshire. This was the initial case in the epidemic. No subsequent case was confirmed in which animals had evidence of earlier disease.

2. A very full inquiry has been made into the origin of the infection. I have considered all the possible means by which foot-and-mouth disease virus could have been brought to this original case, including movements of animals and persons, mechanical carriage by birds and wind, materials used on the farm, infection remaining from sources in the United Kingdom, and imported meat.

3. *Movements of animals and persons.* There was no possibility that the disease was brought on to the farm in animals because the only movement on to the farm was a boar which subsequent investigation showed could not have brought the disease. No one in the household had been abroad and there had been no foreign visitors on the farm, so that the possibility of the disease being introduced by human agency can be disregarded.

4. *Mechanical carriage by birds and wind.* Infection in the past has reached the Eastern and Southern parts of this country from Europe, possibly carried by birds, when there have been epidemics in the countries across the English Channel, but the foot-and-mouth disease situation on the Continent has improved greatly in 1967. Denmark and Holland have been clear since April; France has had only 17 cases, the last occuring in early September in the Departmente of Correze in the southern part of central France where it was eradicated by a vigorous slaughter policy. It is true that Western Germany has experienced serious epidemics in 1965 and 1966, and had over 3,000 cases in 1967, but I consider the distance is too great for the disease to have been brought from Germany to Shropshire by birds, or by the wind. In any case, the prevailing winds over the three weeks before the outbreak were such as to rule out wind-borne infection.

5. *Materials used on the farm.* The importation of hay and straw is prohibited from dangerous sources; and no imported hay and straw had been used on the farm.

6. *Infection from sources in the United Kingdom.* The last previous outbreak was in Warwickshire. Infection was confined to four farms and the area was cleared on 29th September. It is impossible for infection to have remained quiescent in the intervening period and in any case there were no movements of animals between Warwickshire and Bryn Farm.

7. In the early days of October 1967 there was an escape of virus in an isolation compound at the Animal Virus Research Institute, Pirbright. Due to a breakdown in the air filtration system, infection escaped from one unit to another, a distance of approximately 30–40 yards. This occurred in cool humid weather with strong south-westerly winds, so that infection could not have been spread to the north by this means. None of the workers from Pirbright went to the Oswestry district at the material time, nor were any vehicles sent there. This incident cannot be considered as the origin of the outbreak on Bryn Farm.

8. *Imported meat.* My inquiries showed that the only supplies of imported meat of any consequence distributed in the district at the relevant time were frozen lamb from Australia, New Zealand and South America. The first two are free from foot-and-mouth disease and can be discounted. Inquiry has shown that the butcher who supplies the Bryn Farm household purchased his supplies of imported meat from the F.M.C. at Wrexham. He had received, as well as New Zealand lamb, 113 carcases of frozen Argentine lamb.

9. Throughout October, both frozen lamb and lamb bones for the dogs were supplied to Bryn Farm by this butcher. It has not been possible to establish whether these supplies were of New Zealand or Argentine origin.

10. Disease on Bryn Farm was confirmed in pigs, two of which showed older lesions than the others. These were two gilts which had been in the yard and in a field adjacent to the stockyard a week before disease was reported. Cattle were not affected at the time of diagnosis nor when the stock was slaughtered, so that the disease must have originated in the pigs.

11. The owner did not feed swill to his pigs, but bones were fed to his dogs and could have been carried into the yard or neighbouring fields where the gilts had been. In fact the veterinary officers responsible for slaughter and burial of the animals saw bones in the yard at the farm. The owner stated that bones were boiled and fed to the dogs but did not claim that this was always done effectively.

12. It was not possible to establish conclusively that imported frozen lamb carried foot-and-mouth disease virus to the farm, but as all other generally recognised sources of infection had been eliminated, it remained the most probable vector.

Other cases in the epidemic

13. Undoubtedly a majority of the subsequent cases in the epidemic were the result of local spread by various means including perhaps birds and the wind. However, a particularly worrying feature in the first four weeks of the epidemic was the large number of cases which were reported almost simultaneously over a wide area. There had been no movement of animals, and stockowners were generally reporting their suspicions very soon after clinical signs became apparent. This strongly suggested the possibliity that several primary cases occurred at about the same time. Here again there is a possible link with the imported frozen lamb carcases.

14. The carcases of Argentine lamb received by the butcher who supplied Bryn Farm were part of a consignment of 770 frozen lamb carcases which had been despatched from Establishment 1408 in the Argentine and arrived at Wrexham on 25th August. The remainder of these 770 carcases were distributed over a wide area around Wrexham, including deliveries to Ellesmere, Shrewsbury, Prees, Market Drayton, Nantwich and Chester. This is the area of the greatest concentration of infection in the first four weeks of the epidemic. Because these carcases had been distributed it was not possible to take any samples for examination. Samples were taken from other lamb carcases from the Argentine and the results were negative.

15. Other consignments of lamb carcases from Establishment 1408 have been traced. The great weight of distribution was in Nottingham, the West Midlands and London (which also supplied lamb to the West Midlands); smaller quantities were, however, supplied to the Southampton-Portsmouth district, Bristol and South Wales, and Newcastle.

16. At a subsequent stage in the epidemic new unexplained foci of disease cropped up as far east as Lincoln and as far south as Brandon, near Coventry, all during a period of a complete standstill on animal movements. On some of these farms a connection has been established with frozen lamb from Establishment 1408, but in no case is there strong evidence that this lamb was responsible for the outbreak. Some examples are given in the Appendix.

17. Inquiries as to the possible origin of infection are continuing in two outbreaks, and the distribution of the meat is being examined in areas where it was sold, apparently without causing foot-and-mouth disease infection.

18. The only type of virus isolated in this epidemic was 0_1. It is known that this type of virus is present in South America, but it has not been possible to ascertain the situation regarding foot-and-mouth disease in sheep and the prevalent types of virus in the area which supplies Establishment 1408. It is known from returns made by the Argentine authorities that foot-and-mouth disease occurs in the exporting area concerned but the returns do not distinguish between cattle and sheep.

Conclusion

19. My conclusions on the origin of the epidemic are:

(i) I have been unable to discover any possible source of the infection except Argentine lamb.

(ii) Although there is not conclusive evidence that Argentine lamb was the source, I am of the opinion that there is sufficient circumstantial evidence for concluding that this lamb was the cause of the initial case on Bryn Farm and some of the subsequent cases.

JOHN REID,
Chief Veterinary Officer.

7th February, 1968.

APPENDIX

In the six cases referred to below there were no infected premises within the usually accepted distance for local spread.

D.F.474: A. J. Bridewell & Sons, Courteenhall, Northampton 21.11.67. (Nearest outbreak 50 miles)

This farm did not receive imported meat. It is situated a quarter of a mile from the village of Quinton. It is known that the villagers were receiving meat for their households and bones for their dogs from butchers whose wholesale suppliers had received frozen lamb from Establishment 1408. Cattle in a field to which the villagers' dogs had access were affected.

D.F.9744: Clarke, Carnforth, Lancashire

30.10.67. (Nearest outbreak over 80 miles)

This was regarded as a primary outbreak. Argentine lamb probably from Establishment 1408 was received in cardboard cartons by a school canteen at Carnforth in mid-October. The cartons were disposed of at the local refuse tip. The tip is heavily scavenged by birds. The infected Place is approximately 3 miles from the tip.

D.F.1696: Buxton, Penkridge, Staffordshire

18.12.67. (Nearest outbreak 9 miles)

This isolated outbreak was confirmed on 18th December. The cowman on this farm has five dogs which have been fed on raw meat. The cowman obtained his household supplies and meat for his dogs from sources which had received frozen lamb from Establishment 1408. The dogs have access to pasture land on the farm.

D.F.1740: Redfern, Little Eaton, Derbyshire

20.12.67. (Nearest outbreak 7 miles)

Meat supplies to the farmer's household did not include imported material but at a neighbouring bungalow adjacent to the field in which the infected animals were grazing and in which the owner had four Alsatians, meat and bones were received from a supplier who received frozen lamb from Establishment 1408. A bone was found in the " infected " field, to which the dogs had access.

D.F.1797: Wardrop, Hopwell, Derbyshire

23.12.67. (Nearest outbreak 16 miles)

Meat is purchased from a firm which received lamb from Establishment 1408. Household refuse is disposed of on the premises and rats and dogs would have access to it.

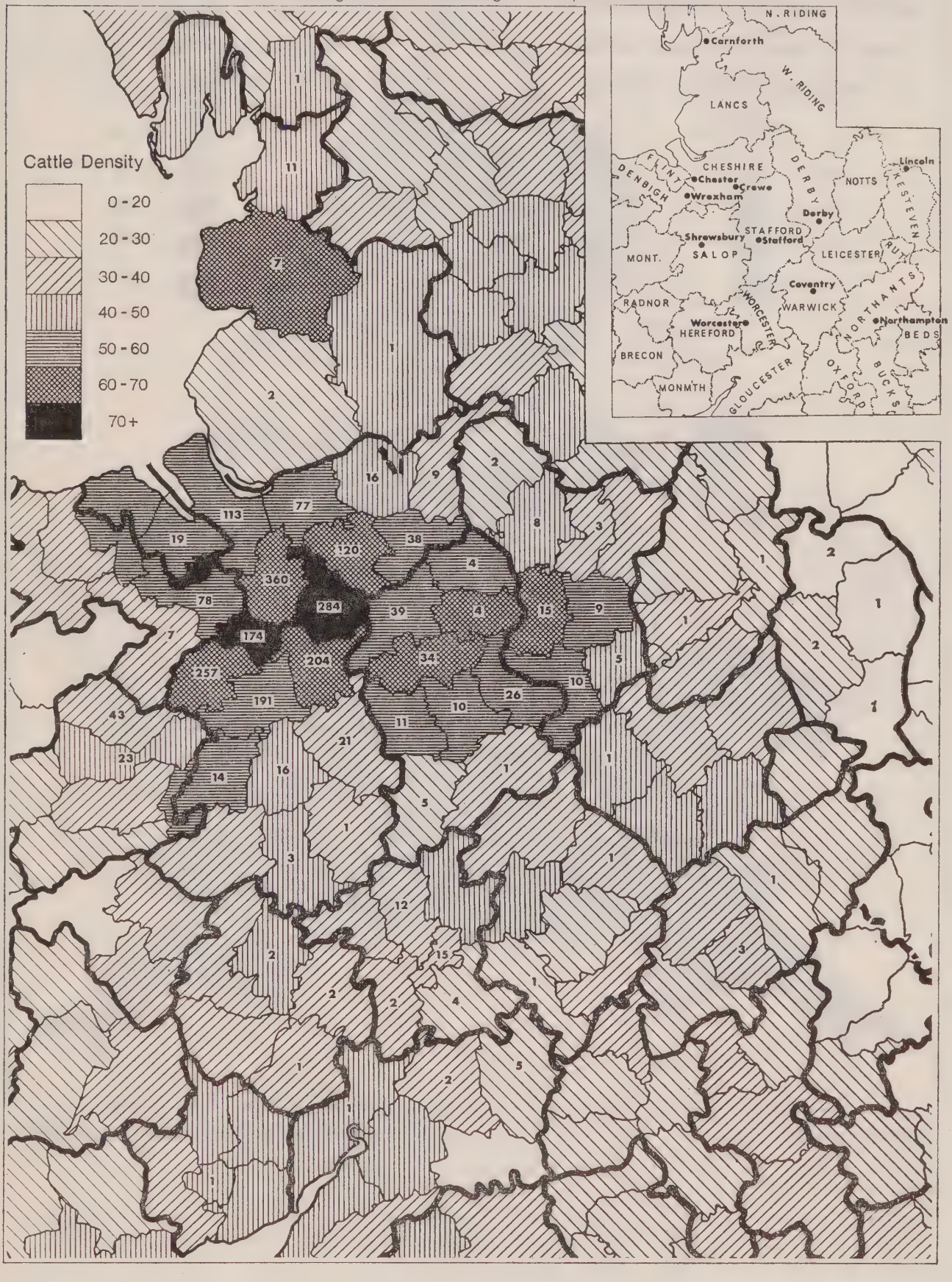
D.F.1929: Potter, Woodborough, Nottinghamshire

1.1.68. (Nearest outbreak 16 miles)

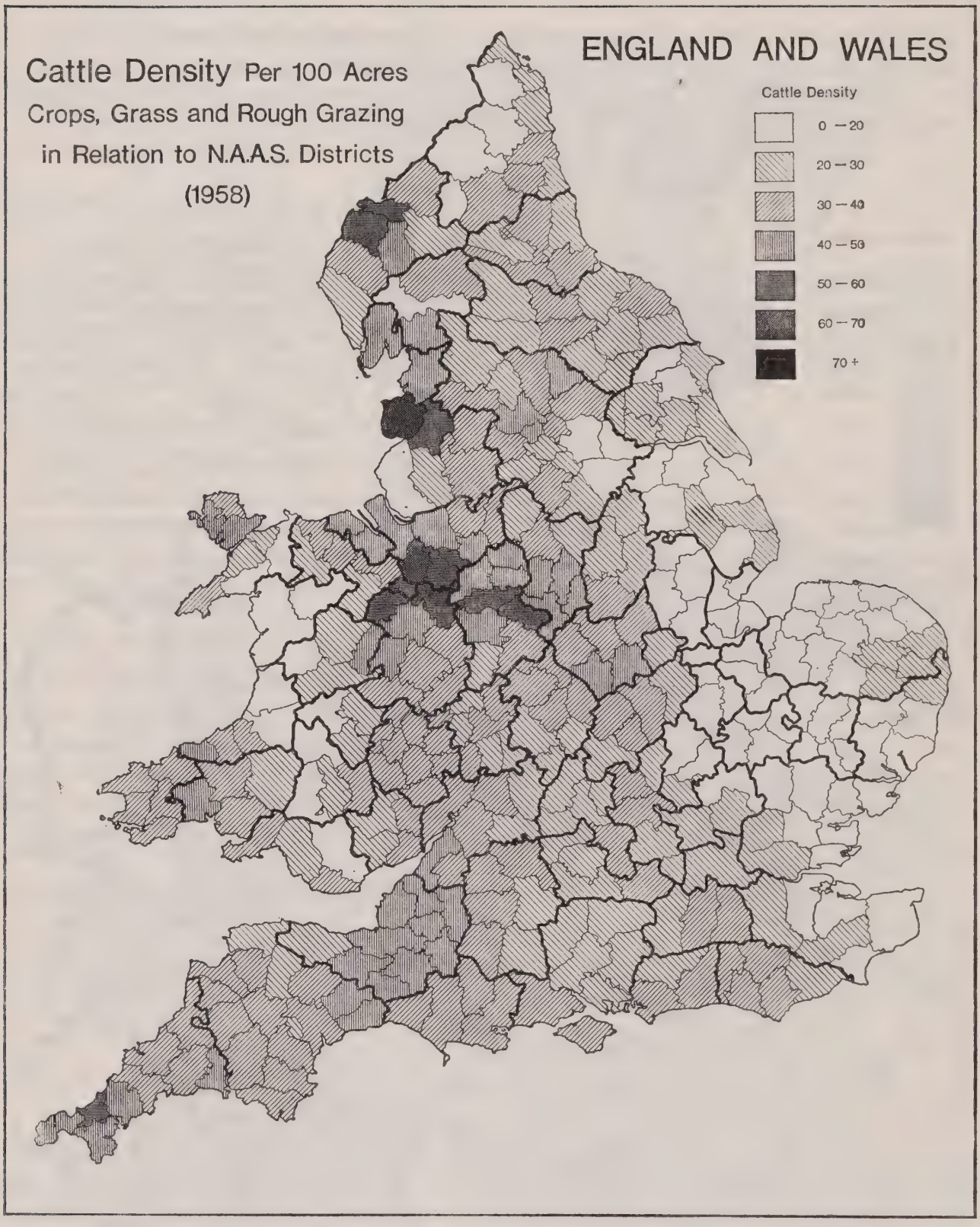
The meat supply to the house is not involved, but 2 miles from the farm there is a bone transhipment depot accessible to birds, dogs and foxes. These bones are collected from butchers' shops which are known to have had imported meat, including frozen lamb from Establishment 1408.

Distribution of Outbreaks of Foot and Mouth Disease in Relation to Cattle Densities in N.A.A.S. Districts

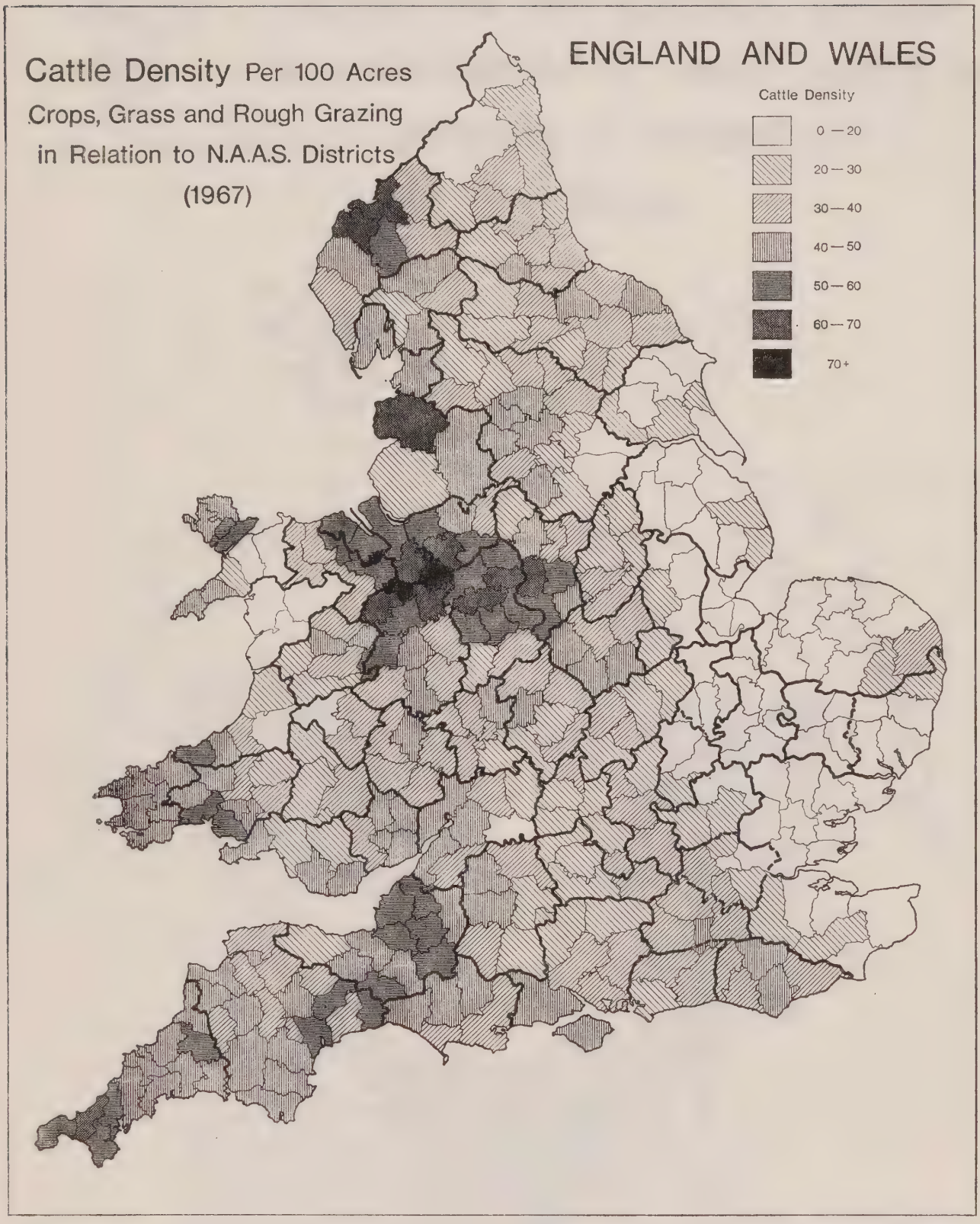
Counties are sub divided into National Agricultural Advisory Service (N.A.A.S.) districts.
(Average number of holdings is 500 per district.)



Source:- Ministry of Agriculture



Source:- Department of Agriculture and Fisheries for Scotland

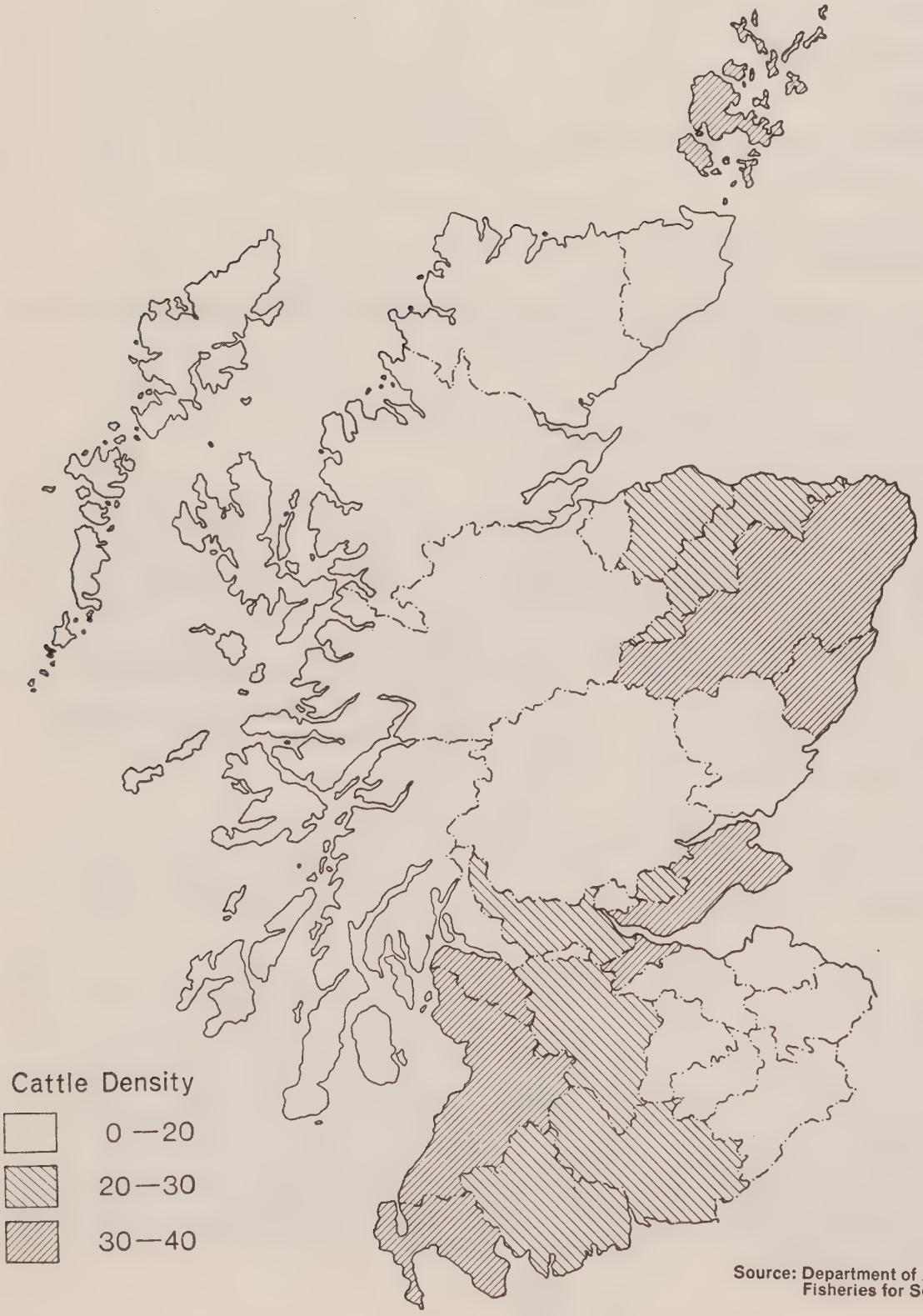


Source:- Ministry of Agriculture

SCOTLAND
Cattle Density Per 100 Acres of Crops, Grass and Rough Grazing in Relation to Counties (1958)

Source:- Ministry of Agriculture

SCOTLAND
Cattle Density Per 100 Acres of Crops, Grass and Rough Grazing in Relation to Counties (1967)



Source: Department of Agriculture and Fisheries for Scotland

LEGISLATION TO CONTROL THE INTRODUCTION OF FOOT-AND-MOUTH DISEASE VIRUS INTO GREAT BRITAIN

CARCASE MEAT AND OFFAL

1. *The Importation of Carcase and Animal Products Order*, 1954, as amended, sets out a number of countries (all of them free from Foot-and-Mouth Disease) from whom all meat and meat products are admitted unconditionally into Great Britain. These are

Australia
Canada
Falkland Islands
Finland
Iceland
Irish Republic
Norway
New Zealand

South Africa was included in this list but was removed following an outbreak of Foot-and-Mouth Disease there in December, 1967.

2. The Order also controls imports from *other countries:*

(*a*) **Meat**

Until 4th December, 1967, when imports of fresh meat and offal were suspended from all countries other than those from which supplies were admitted unconditionally (see paragraph 1 above), detailed veterinary requirements were set out in the Third Schedule for imports from a number of countries: imports from other countries were also permitted under licences. When the ban on imports was lifted on 15th April, 1968, the operation of the Third Schedule remained suspended and all imports from countries other than those listed in paragraph 1 are subject to licence. These licences specify conditions designed to ensure insulation from disease

(i) *For countries other than those in South America*

They include certification that the farm of origin of the animals, and the slaughterhouse where they are slaughtered, must be at least 20 km. (12½ miles) from any known outbreak of disease; that the animals have had no contact with other animals from within such a 20 km. area; and that they should be subject to ante and post-mortem inspection. These conditions are varied somewhat for countries in Africa to take account of the different conditions in those countries. For example, in the Republic of South Africa the required distance from known disease is stipulated at 40 miles rather than 20 km. (12½ miles) while in South West Africa and Botswana the whole of the game-fenced and controlled compartment from which the stock is drawn must be free from disease, and in the case of Swaziland freedom of the whole country from disease is required. Licences are available for imports from the following countries:—

Europe	*Africa*	*N. America*
Austria*	Botswana*	U.S.A.* §
Belgium†	Republic of S. Africa‡	Cuba *
Bulgaria*	South West Africa*	(Costa Rica*—
Denmark‡	Swaziland*	under consideration)
France†		
Holland†		
Hungary*		
Poland†		
Rumania*		
Sweden‡		
Switzerland*		
Yugoslavia*		
(Czechoslovakia*— under consideration)		

Notes

* Beef only
†Beef and mutton and lamb
‡Beef, mutton and lamb and pork
§Pork under special precautions solely for the United States Forces

(ii) *Argentina, Brazil, Chile and Uruguay*

Beef and beef offal are allowed into Great Britain from these countries subject to certification that they come from frigorificos on an approved list drawn up by the Ministry of Agriculture, Fisheries and Food. To be on the approved list implies that a frigorifico meets with the requirements of the Bledisloe arrangements which provide that the animals for slaughter should come only from estancias free of Foot-and-Mouth Disease; that appropriate disinfection procedures should be adopted during their transportation; that they have received ante and post-mortem inspection and that the slaughterhouse should be free from disease. In addition, the Governments of these countries have agreed to require that foot-and-mouth disease shall be compulsorily notifiable, that movements of stock shall be prohibited from affected establishments and that meat for export to Great Britain shall be derived solely from animals vaccinated against Foot-and-Mouth Disease with inactivated vaccine of a standard controlled by the Government Veterinary Service.

(b) Bacon and Ham

Imports are allowed from a number of *European countries* and also from *Cyprus* and the *Republic of South Africa* so long as they are accompanied by a certificate of processing or are marked, in the case of some countries, with the official stamp of that country. The Importation of Carcase and Animal Products Order, 1954 would also permit the importation of bacon and ham on similar terms from approved frigorificos in South America but, in fact, no trade takes place.

(c) Dry Sausage (Salami)

Sausage casings

Imports are allowed from a number of countries, subject to stringent animal health provisions applied in the country of origin.

3. A number of animal products, having regard to their mode of preparation and use, present negligible animal disease risks and are admitted either unconditionally (e.g. bone charcoal and steamed bone flour) or subject to certification of their method of preparation (e.g. fellmongered goat and cow hair).

LIVESTOCK

4. *The Diseases of Animals Act*, 1950 provides, with certain exceptions, that all imported animals shall be slaughtered at the point of landing. (In practice this provision is not operative as animals are no longer imported for slaughter from outside the British Isles.) The exceptions are for animals from Ireland, Channel Islands and the Isle of Man, Canada and, subject to special arrangement for quarantine and testing, for exhibition in Zoos; but animals may occasionally be imported from other countries or for other purposes under separate Orders made for each individual importation. To ensure that, so far as is practicable, imported animals are disease-free the Orders provide for testing the animals for presence of virus before embarkation, and quarantine both before and after shipment. These arrangements apply to such importations as pedigree animals coming from the Commonwealth and animals brought in for exhibition or other exceptional purposes such as breed improvement.

WRAPPING MATERIALS

5. *The Importation of Meat etc.* (*Wrapping Materials*) *Orders of* 1932 *and* 1939 specify the only kind of materials which may be used and the markings which must appear on them to identify them as meat wrappings. The use of these materials for any other purpose such as packing feedingstuffs, bedding, fertilisers, agricultural and horticultural produce is forbidden. Further, the *Foot-and-Mouth Disease* (*Packing Materials*) *Order* 1925, as amended, provides that no animal in Great Britain should be brought into contact with boxes or wrapping material used for wrapping meat or uncooked meat products.

HAY, STRAW, DRIED GRASS

6. *The Importation of Hay, Straw and Dried Grass Order*, 1961 prohibits the importation of hay and straw except from certain countries which are free from Foot-and-Mouth Disease unless it is being used as packing material, forms part of a manufactured article, or is licensed for other than animal use. When hay or straw has been used for packing purposes it must be kept away from animals in Great Britain and should be destroyed once used, unless it is to be used again as packing material. These latter requirements are provided for in the Foot-and-Mouth Disease (Packing Materials) Order of 1925.

SEMEN

7. *The Importation of Animal Semen Order*, 1955 as amended, prohibits, except under licence, the importation of semen of, among others, horses, sheep, goats and all other ruminating animals (except cattle) into Great Britain. A licence to import semen may lay down any conditions which Ministers may think fit to impose for the purpose of preventing the introduction or spread of disease.

8. The importation of cattle and pig semen is controlled by the *Agriculture* (*Miscellaneous Provisions*) *Act*, 1943 under which licences are issued which again are subject to stringent veterinary safeguards.

SERA AND GLANDULAR PRODUCTS

9. The use of sera and glandular products in the treatment of cattle, sheep, goats, other ruminating animals or swine is prohibited under the *Foot-and-Mouth Disease* (*Sera and Glandular Products*) *Order*, 1939, unless the substance carries the authorisation of the Minister.

THERAPEUTIC SUBSTANCES

10. *The Diseases of Animals* (*Therapeutic Substances*) *Order of* 1952 prohibits, except under licence, the manufacture or importation of therapeutic substances, including sera and vaccines.

SWILL

11. *The Diseases of Animals* (*Waste Foods*) *Order*, 1957 prohibits in general the feeding to cattle, sheep, pigs, goats or poultry waste foods which contain or have been in contact with anything that is part of a carcase unless the food has been boiled for at least one hour. Under the provisions of the Order it is an offence to allow any of the above named animals access to unboiled food waste. Local authorities are required to licence swill boiling plants and to subject them to inspection. There is an exception to this licensing rule for small farmers, i.e. with less than 4 pigs and 50 poultry.

PASSENGER AND VEHICULAR TRAFFIC

12. There is at present no permanent legislative control over the movement of people into or within Great Britain. During an outbreak of Foot-and-Mouth Disease the provisions of the *Diseases of Animals Act*, 1950 could be used in exceptional circumstances to impose movement restrictions within Great Britain if these were considered necessary to prevent the spread of disease. For example, during the 1967/1968 epidemic the Minister of Agriculture made the *Foot-and-Mouth Disease* (*Temporary Restrictions*) *Order*, 1967 which authorised the prohibition by notice in writing of entry by people onto agricultural or adjoining land. This was a temporary Order which was subsequently revoked. There are however certain restrictions on vehicles used for ferrying livestock to and from the Continent. Under the *Transit of Animals* (*Amendment*) *Order*, 1931 it is obligatory to clean and disinfect a vehicle that has carried animals after use and before carrying other animals.

SUMMARY OF THE BLEDISLOE AGREEMENT, 1928

Article 1. No cattle, sheep or pigs shall be slaughtered unless accompanied by a veterinary certificate of soundness in accordance with the prescribed conditions.

Article 2. No animals will be moved from the place of origin unless the livestock on that establishment have had veterinary inspection and been found free from contagious disease, and that the stock to be removed shall have been found healthy not more than two days before removal.

Article 3. The wagons or other transport shall be cleaned and disinfected by the transporting companies.

Article 4. Persons concerned with forwarding livestock shall notify Government authorities in time for examination before despatch.

Article 5. Animals sold through markets shall be subjected to special examination in addition to examination at the place of origin.

Article 6. Herds brought in on foot shall comply so far as possible with similar conditions.

Article 7. All animals shall be inspected ante and post-mortem and the consignment shall be rejected if foot-and-mouth disease is found.

Articles 8 *and* 9. In the event of disease, the yards where animals have been shall be specially cleaned and disinfected.

Article 10. All meat wrappings shall be new.

Article 11. Concerns salaries and staff.

Article 12. Provides for punishment of contraventions.

SUMMARY OF CONDITIONS CURRENTLY APPLICABLE FOR THE EXPORT OF BEEF AND BEEF OFFAL* FROM ARGENTINA, BRAZIL, CHILE† AND URUGUAY

1. Foot-and-mouth disease must be compulsorily notifiable by owners of stock.

2. If foot-and-mouth disease is confirmed movement of all susceptible species from the affected establishment (e.g. estancia) must be prohibited for at least 30 days after the detection of the last clinical case, subject to a minimum standstill period of 60 days.

3. Any animal intended for slaughter for export to the U.K. (in the form of carcase meat, offal or meat products) must have been vaccinated against foot-and-mouth disease at least twice at an interval of not more than six months; the last vaccination to have taken place not more than 4 months and not less than 15 days before slaughter. All vaccination to be with inactivated vaccine controlled for innocuity and potency by the Government Veterinary Service.

4. No animals to be loaded into vehicles which have not been properly cleansed and disinfected.

5. All markets and fairs to be inspected by Government Veterinarians. If foot-and-mouth disease is found no affected animal or animal in contact with any affected animal to be allowed to go to frigorificos approved for the export of meat or meat products to the U.K.

6. Lairage facilities at approved frigorificos to be adequate and capable of being thoroughly cleansed. Thorough cleansing to be carried out before the entry of each troup of animals. Facilities to include accommodation for the isolation of any diseased or suspect animal.

7. Ante mortem inspection by Government Veterinarian and any sick animals (from whatever cause) to be segregated immediately. If foot-and-mouth disease is found or suspected no carcase meat or offal to be exported to the U.K. from any animal in the troup and the pens to be thoroughly cleansed and disinfected after removal of the animals.

8. Post mortem examination of all export production under the direct supervision of a Government Veterinarian. If foot-and-mouth disease is found or suspected, carcases and offal of affected animals and of all those animals in contact before slaughter or during slaughter and dressing to be excluded from export to U.K. Thorough cleansing of facilities to be carried out before production for export to U.K. is resumed.

9. Packings, coverings and wrappings of meat and offal intended for export to the U.K. to be entirely new.

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* No mutton, lamb, or uncured pigmeat permitted to be imported.
† Imports from Chile at present suspended for public health reasons.

UNITED KINGDOM
IMPORTS OF CARCASE MEAT AND OFFAL

	Quantity '000 tons						
	1962	1963	1964	1965	1966	1967	1968
Fresh Beef							
Irish Republic	20·3	17·4	16·5	25·8	35·1	94·6	78·7
Other Countries	...	...	0·8	...	...	0·6	11·2
Total	20·3	17·4	17·3	25·9	35·2	95·2	89·9
Chilled Beef							
Rhodesia	4·7	4·7	3·3	3·7	—	—	—
Australia	1·7	—	0·3	0·1	0·1	—	...
New Zealand	0·3	—	0·7	0·6	0·1	...	—
Other Commonwealth Countries	0·6	—	—	—	—	—	—
Irish Republic	0·7	0·1	0·2	0·2	1·6	9·3	6·8
Sweden	1·0	0·8	...	—	0·1	...	0·4
Hungary	0·4	0·1	...	...	—	—	—
Yugoslavia	34·1	12·3	13·0	5·5	3·4	0·2	17·8
Republic of South Africa	0·7	0·4	1·3	1·1	0·9	...	...
Brazil	1·2	1·9	0·2	0·1	0·8	0·2	1·9
Uruguay	10·3	26·3	20·7	2·8	6·9	4·1	13·0
Argentine Republic	157·9	201·3	128·7	95·3	108·7	88·0	15·2
Other Foreign Countries	...	0·1	0·2	1·6	1·0	1·8	4·3
Total	213·6	247·9	168·6	111·1	123·6	103·7	59·4
*Frozen Beef**							
Basutoland	5·2	—	—	—	—	—	—
Botswana		6·6	5·5	9·1	9·9	3·7	2·7
Swaziland						0·8	0·4
Rhodesia	3·3	3·1	1·7	1·6	—	—	—
Australia	31·3	17·0	81·6	88·7	66·5	18·3	24·5
New Zealand	6·2	1·9	24·6	28·3	18·7	8·6	9·3
Other Commonwealth Countries	...	0·1	0·1	0·1	0·1	0·1	1·2
Irish Republic	0·6	0·5	3·2	2·3	4·1	4·1	4·7
Sweden	2·1	3·4	0·1	...	0·3	0·2	0·9
Norway	0·2	0·7	...	...	—	0·2	—
Netherlands	0·7	0·7	0·6	0·6	0·3	0·4	1·5
Yugoslavia	5·1	2·3	0·4	0·2	0·3	0·3	9·5
Republic of South Africa	2·2	2·4	1·1	2·1	8·0	4·9	1·6
U.S.A.	0·3	0·3	1·2	0·5	0·3	0·4	1·6
Brazil	0·1	0·5	0·8	0·2	0·5	0·1	2·8
Uruguay	6·8	14·6	11·1	1·5	3·2	4·6	11·3
Argentine Republic	23·6	34·2	20·7	13·0	9·6	13·4	19·1
South West Africa	—	—	—	0·3	1·9	1·6	0·9
Other Foreign Countries	...	—	0·2	—	0·1	6·7	14·2
Total	87·6	88·1	152·9	148·5	124·0	68·5	106·2

Note: The entries in these Tables are rounded figures and small quantities (shown as ...) are omitted from the entries against countries. For these reasons the totals are not the sum of the entries for countries.

* Small quantities of fresh and chilled boned and boneless beef are included in this group.

	Quantity '000 tons						
	1962	1963	1964	1965	1966	1967	1968
Veal							
Australia	1·8	1·2	2·7	1·8	1·2	0·4	0·4
New Zealand	1·0	0·2	0·8	0·4	0·3	0·2	0·1
Other Commonwealth Countries	0·1	—	—	—	...	—	—
Denmark	0·1	0·1	0·4	0·3	0·7	0·9	0·5
Netherlands	3·0	2·6	2·1	2·2	0·6	0·2	0·2
Other Foreign Countries ..	0·1	...	0·1	...	0·1	0·1	0·2
Total	6·1	4·2	6·2	4·7	2·8	1·8	1·4
All Beef and Veal							
Basutoland	5·9	—	—	—	—	—	—
Botswana		6·6	5·5	9·1	9·9	3·7	2·7
Swaziland						0·8	0·4
Rhodesia	7·9	7·7	5·1	5·3	—	—	—
Australia	34·9	18·2	84·7	90·6	67·7	18·7	24·9
New Zealand	7·5	2·1	26·1	29·2	19·1	8·8	9·4
Other Commonwealth Countries	...	0·1	0·1	0·1	0·1	0·1	1·2
Irish Republic	21·6	19·0	19·9	28·4	40·9	108·0	90·3
Sweden	3·1	4·2	0·1	...	0·3	0·2	1·6
Norway	0·2	0·7	...	...	—	0·2	—
Denmark	0·2	0·1	0·4	0·3	0·7	1·4	4·6
Netherlands	3·7	3·2	2·7	3·0	0·9	0·7	1·8
Yugoslavia	39·2	14·6	13·5	5·7	3·7	0·5	27·3
Republic of South Africa ..	2·9	2·8	2·4	3·2	8·9	5·0	1·6
U.S.A.	0·3	0·3	1·2	0·5	0·4	0·5	1·6
Brazil	1·3	2·5	1·0	0·3	1·3	0·3	4·7
Uruguay	17·2	40·9	31·8	4·2	10·1	8·6	24·3
Argentine Republic	181·5	235·5	149·4	108·3	118·4	101·4	34·4
South West Africa	0·4	—	—	0·3	1·9	1·6	0·9
Rumania		—	—	...	0·1	5·1	3·6
Poland		—	0·1	1·4	0·9	1·5	3·9
France		...	0·9	...	0·2	0·7	13·9
Iceland		—	—	—	...	0·6	0·2
Other Foreign Countries ..		0·2	0·1	...	...	0·6	3·5
Total	327·6	357·6	345·0	290·1	285·5	269·0	256·9

...=small quantities.

	Quantity '000 tons						
	1962	1963	1964	1965	1966	1967	1968
Mutton							
Australia	7·9	6·1	8·1	8·9	3·7	4·8	7·0
New Zealand	35·2	25·3	27·2	28·0	12·4	20·2	32·3
Canada	—	—	—	—	—	—	0·8
Other Commonwealth Countries	—	—	—	—	—	—	—
Irish Republic	0·2	0·2	0·2	0·1	0·5	0·3	0·1
Iceland	—	—	...	...	...	...	0·1
U.S.A.	...	0·2	0·3	0·1	0·7	0·4	2·1
Uruguay	—	0·1	...	0·6	—	—	—
Argentine Republic	0·1	0·1	...	0·6	...	0·3	—
Other Foreign Countries	...	...	...	...	...	...	...
Total	43·4	32·0	35·8	38·3	17·3	26·0	42·5
Lamb							
Australia	14·4	16·6	14·4	14·1	6·7	4·5	9·4
New Zealand	256·2	257·3	265·9	266·5	258·7	276·6	285·1
Other Commonwealth Countries	...	0·1	—	...	...	—	—
Irish Republic	13·2	10·9	8·9	9·2	11·2	9·8	6·0
Iceland	2·5	2·1	1·2	1·0	0·7	2·8	3·6
Netherlands	...	...	—	...	...	—	—
U.S.A.	0·1	0·3	0·3	0·2	0·2	...	0·1
Chile	0·9	0·9	0·3	0·8	0·5	0·7	—
Uruguay	—	0·3	—	0·8	0·2	...	—
Argentine Republic	21·0	21·8	11·9	14·2	20·0	18·1	—
Other Foreign Countries	0·1	0·2	0·2	...	...	0·1	...
Total	308·3	310·4	303·1	306·7	298·3	312·7	304·3
Pork							
Australia	...	—	—	...	—	—	—
New Zealand	0·7	0·4	0·3	0·8	0·1	0·1	0·3
Other Commonwealth Countries	...	0·1	0·3	...	0·3	0·4	0·2
Irish Republic	8·4	7·8	5·6	16·4	5·8	2·3	8·2
Sweden	4·7	0·6	0·7	1·1	1·8	0·9	1·6
Norway	0·3	...	—	0·3	—	—	—
Denmark	0·4	0·2	0·2	0·2	0·1	0·2	1·7
Netherlands	1·9	0·5	0·1	0·1	...	...	—
Yugoslavia	3·1	1·6	2·3	1·5	1·0	0·3	—
Republic of South Africa	0·3	0·1	...	0·1	1·1	0·5	0·4
Argentine Republic	...	—	—	—	—	—	—
Finland	...	—	—	...	...	6·1	5·6
Other Foreign Countries	...	...	...	...	0·2	...	...
Total	19·8	11·3	9·7	20·6	10·3	10·9	18·0

...= small quantities.

	Quantity '000 tons						
	1962	1963	1964	1965	1966	1967	1968
Beef and Veal Offal							
Basutoland	0·2	—	—	—	—	—	—
Botswana		0·3	0·2	0·5	0·6	0·3	0·1
Swaziland						...	—
Rhodesia	0·5	0·5	0·4	0·2	—	—	—
Australia	10·4	10·9	12·2	12·3	11·7	8·4	10·0
New Zealand	3·4	4·2	4·6	4·0	4·1	4·5	6·6
Canada	1·6	1·9	3·3	4·4	3·8	2·5	3·7
Other Commonwealth Countries	—	...	...	...	...	...	—
Irish Republic	2·8	2·2	1·7	1·9	2·4	4·7	4·8
Sweden	0·4	0·4	0·4	0·4	0·4	0·4	0·4
Denmark	1·4	1·4	1·3	1·3	0·9	1·9	1·5
Netherlands	0·5	0·9	0·2	0·8	0·5	0·3	0·2
Yugoslavia	0·8	0·8	0·4	0·1	0·2	0·1	0·1
U.S.A.	10·7	8·6	15·3	18·2	17·2	15·7	18·2
Brazil	0·5	0·4	0·9	0·9	0·5	0·3	0·5
Uruguay	0·5	0·4	0·4	0·3	0·2	0·7	0·8
Argentine Republic	10·7	18·1	12·4	9·6	9·7	10·2	6·2
Republic of South Africa ..	0·1	0·1	0·1	0·2	0·3	0·1	...
Other Foreign Countries ..					0·4	0·2	0·2
Total	44·4	51·2	53·8	55·0	52·9	50·2	53·1
Mutton and Lamb Offal							
Australia	4·3	4·4	4·3	4·4	6·0	5·3	6·8
New Zealand	13·3	13·3	14·7	15·2	15·6	19·0	20·6
Canada	0·1	0·1	0·1	0·1	...	...	...
Other Commonwealth Countries	—	...	—	—	—	...	—
Irish Republic	0·8	0·8	0·8	0·6	0·7	0·7	0·6
Iceland	0·3	0·3	0·3	0·2	0·4	0·4	0·4
Netherlands	0·2	0·2	0·1	0·2	...	0·1	...
U.S.A.	3·9	4·0	4·9	5·2	5·0	4·5	4·3
Chile	0·1	0·8	0·1	0·1	0·1	0·2	—
Argentine Republic	1·1	1·5	1·2	1·7	2·1	2·2	—
Other Foreign Countries ..	0·1	0·1	0·1	0·2	0·2	0·1	...
Total	24·1	25·5	26·5	27·8	30·2	32·5	32·8

...=small quantities.

	Quantity '000 tons						
	1962	1963	1964	1965	1966	1967	1968
Pork Offal							
Australia	0·3	0·3	0·2	0·2	0·2	0·2	0·1
New Zealand	0·3	0·3	0·4	0·4	0·4	0·3	0·3
Canada	1·6	2·4	3·4	3·4	3·1	3·4	5·0
Other Commonwealth Countries	...	...	...	—	—	—	—
Irish Republic	2·7	2·3	2·7	3·1	2·9	2·6	3·1
Sweden	0·4	0·3	0·4	0·4	0·4	0·4	0·9
Denmark	8·8	9·7	11·6	14·7	12·2	13·2	14·1
Netherlands	1·4	0·6	0·4	0·4	0·1	...	—
Yugoslavia	0·6	0·5	0·4	0·3	0·1	...	—
Republic of South Africa	0·1	0·1	0·1	0·1	0·1	0·1	0·1
Argentine Republic	...	—	...	...	...	—	—
Other Foreign Countries	...	...	0·1	0·5	0·2	0·2	0·2
Total	16·3	16·5	19·7	23·6	19·6	20·6	23·8
Total all Carcase Meat and Offal							
Basutoland	6·1	—	—	—	—	—	—
Botswana		6·9	5·7	9·6	10·5	4·0	2·9
Swaziland						0·8	0·4
Rhodesia	8·4	8·3	5·5	5·6	—	—	—
Australia	72·2	56·5	124·0	130·5	96·0	41·8	58·2
New Zealand	316·5	302·9	339·2	344·1	310·4	329·5	354·5
Canada	3·3	4·6	7·3	8·0	7·3	6·4	11·0
Other Commonwealth Countries	...	0·1	...	...	...	...	—
Irish Republic	49·6	42·2	40·0	59·7	64·4	128·4	113·1
Sweden	8·6	5·4	1·6	1·9	2·9	2·0	4·6
Norway	0·5	0·7	0·1	0·4	0·1	0·4	0·2
Iceland	2·8	2·5	1·5	1·3	1·1	3·9	4·3
Denmark	10·8	11·5	13·6	16·4	13·9	16·8	21·9
Netherlands	7·6	5·3	3·5	4·4	1·5	1·0	1·9
Hungary	0·4	0·1	...	0·1	0·1	...	—
Yugoslavia	43·6	17·6	16·6	7·6	5·0	0·9	27·4
Republic of South Africa	3·3	3·2	2·7	3·4	10·4	5·7	2·1
U.S.A.	15·1	13·5	22·0	24·3	23·5	21·1	26·3
Chile	0·9	1·8	0·4	0·8	0·7	0·9	—
Brazil	1·8	2·9	1·9	1·2	1·9	0·6	5·1
Uruguay	17·7	41·7	32·2	6·0	10·6	9·4	25·1
Argentine Republic	214·4	277·0	175·0	134·3	150·3	132·2	40·6
Finland	...	...	...	...	0·1	6·3	5·7
France	...	...	1·0	...	0·2	0·9	14·0
Poland	...	...	0·1	1·4	0·9	1·5	3·9
Belgium	—	—	...	...	...	0·6	1·0
Rumania	—	—	0·1	...	0·1	5·1	3·6
South West Africa	—	—	—	0·3	2·1	1·6	0·9
Other Foreign Countries	...	—	...	0·5	0·1	0·1	2·6
Total	783·9	804·5	793·8	762·1	714·3	722·0	731·4

... = small quantities.

	Quantity '000 tons						
	1962	1963	1964	1965	1966	1967	1968
*Bacon***							
Commonwealth Countries ..	...	...	...	...	0·1	—	—
Irish Republic	26·1	25·9	27·8	26·4	27·7	23·4	28·2
Sweden	9·9	8·8	9·1	10·6	10·6	11·1	10·7
Denmark	289·1	286·5	290·1	299·5	297·8	300·1	299·5
Poland	50·1	50·6	50·4	50·9	51·8	54·0	53·4
Netherlands	15·7	8·6	9·1	6·2	4·4	8·1	8·7
Belgium..	0·1	0·1	0·1	0·2	0·1	0·2	0·3
Hungary	2·0	1·7	2·3	2·2	1·8	2·3	2·5
Yugoslavia	4·8	2·5	1·8	0·7	—	—	—
Rumania	—	—	...	0·1	0·6	0·8	1·5
Republic of South Africa ..	0·7	...	...	0·3	2·0	1·9	1·0
Other Foreign Countries ..	...	...	...	...	...	...	...
Total	398·6	384·9	390·7	397·2	397·0	401·9	405·8

** Includes hams in 1962.
... = small quantities.

Printed in England for Her Majesty's Stationery Office
by Harrison & Sons Ltd.
(SO 91856) Dd 148174 K 20 4/69 SBN 10 139990 1

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